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* Deceased August 11, 1938.

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SYMPOSIUM ON ORTHOPEDIC SURGERY

THIS Symposium has been prepared with the idea in mind that the general surgeon as well as the practitioner is becoming more orthopedic-minded, and while he may not wish to undertake the more complicated surgical procedures he desires a working knowledge of the principles underlying treatment so that he can competently advise his patients. The more common conditions in orthopedic surgery have been selected, with the most modern methods of surgical approach.

The following clinics are included in the Symposium:

John Lincoln Porter and Robert C. Loneragan CONGENITAL DISLOCATION OF THE HIP
Robert C. Loneragan SURGICAL TREATMENT OF FLAT FEET INDICATIONS AND TECHNIC
Robert Ritter TREATMENT OF LOW BACK PAIN
Sam W. Banks and Edward L. Compere LESIONS OF THE INTERVERTEBRAL DISK AS RELATED TO BACKACHE AND SCIATIC PAIN
E. J. Berkheiser TREATMENT OF HABILITAC DISLOCATION OF THE SHOULDER
Harold A. Sofield LEG LENGTHENING
Daniel H. Levinthal TENDON TRANSPLANTATION IN THE LOWER EXTREMITY
Emil Hauser MUSCLE IMBALANCE OF THE FOOT
Philip Lewis SURGERY IN INFANTILE PARALYSIS
Fred W. Hark and Henry B. Thomas SCOLIOSIS

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CLINIC OF DRs JOHN LINCOLN PORTER AND ROBERT C LONERGAN

EVANSTON HOSPITAL

CONGENITAL DISLOCATION OF THE HIP

WE have here for a demonstration and discussion a case of congenital dislocation of the hip in a little girl three and one half years old. Before considering the methods of treatment which have been suggested and used with various degrees of success during the past thirty years I want to stress the importance of early diagnosis and the early signs of dislocation which may be observed before the child has walked.

Etiology—We will not waste any time discussing the cause or causes of congenital dislocations, as it is fruitless. There have been many theories advanced but none has been proved, one is as good as another. The really important thing is early diagnosis. Every newborn infant should be suspected of having a congenital dislocation of the hip until it is proved by examination or x rays that it has not. Putti, of Bologna has emphasized the importance of early diagnosis for many years, and has shown that over 90 per cent of the cases can be cured by gradual abduction with a triangular splint in the first two years of life. When we consider the statistics of Steindler, that only 14 per cent of our cases are seen during the first year, it is evident that we are negligent in our examination of the newborn child, as the deformity can easily be detected at birth. When our obstetricians and pediatricians realize the tremendous importance of early diagnosis and treatment before the child has walked and make a thorough examination of the hips of every newborn infant, our results from treatment will be greatly improved—tremendously improved.



looks fuller at the same time note that the gluteal creases are not even in length and the right is slightly lower than the left. The same thing is true of the inguinal folds in front. Now if we lay the child on her back and flex the thighs and knees with both feet flat on the table, it is easily seen that one knee seems higher than the other and actually is. This is confirmed by straightening the legs and measuring from the anterior superior spine to the inner malleolus. We find that the right leg is approximately 1 inch shorter than the left. Next holding the pelvis still with one hand and abducting the left leg to its fullest extent if one of you will try to abduct the right leg you will find that it cannot be abducted as fully as the left. Finally we make the same test that I described for the newborn child and we find that grasping the hip with the thumb in the groin and the two fingers over the trochanter we cannot feel the head of the femur under the thumb on rotation but we do feel a larger mass than normal rotating under the fingers. We resort to the x-ray films as in the younger children not only to demonstrate that the femoral head is displaced but to show the condition of the acetabulum and the upper end of the femur because both will show changes from the normal hip.

Pathologic Anatomy—Before taking up the question of treatment I want to discuss briefly the pathologic anatomy of these cases and especially the very marked differences that are seen in individual cases. Remember that the condition grows increasingly worse after the child begins to walk which is the great argument for early diagnosis and treatment.

Pathologic changes involve the femoral head, the capital epiphysis, the neck of the femur and the acetabulum specifically while changes in the soft parts including the capsule and the ligamentum teres are also present. The x-ray films usually show the acetabulum shallow and the roof oblique. In fact in many cases the acetabulum looks like a small depression without any roof. The femoral head is smaller and flattened and the epiphysis seems narrower than normal. There is always an anterior torsion in the neck of the femur which in the x-ray film makes it seem much shorter than in the normal joint. It is evident that the head of the femur does not develop as rapidly nor as normally outside the acetabulum.

Diagnosis—As I have said the location of the hip can be detected during early infancy by both clinical signs and x-ray films. If the dislocated hip is single the child lies habitually with the dislocated leg rotated outward. The contour of the iliotrochanteric region looks and feels different. With the child lying prone a difference between the two gluteal creases can often be noted and finally careful manual examination of the two hips reveals whether the head of the femur is not in the acetabulum. This examination may require skill and experience but with a little practice I am sure you can demonstrate to yourselves that even in infants with considerable fat the head of the femur can be left in the acetabulum when it is in and can be felt outside of the acetabulum when it is out.

Although this patient is three and one half years old and has walked I will use her to demonstrate the procedure.

In examining the right leg put the thumb of the left hand in the groin and the index and middle fingers behind the trochanter grasp the entire hip rather firmly and with the right hand rotate the leg inward and outward. If the head of the femur is in the acetabulum it will be felt under the thumb when the leg is rotated strongly outward and the trochanter will be felt to move under the other two fingers. If the head is not in the acetabulum nothing is felt under the thumb on rotation outward but a secondary mass is felt by the fingers behind and above the trochanter when the leg is strongly rotated inward. Then with the fingers and thumb in the same position the leg is strongly pulled downward and pushed upward the trochanter will be found to make a decided upward and downward movement which is not felt in the normal hip. Furthermore rotation both inward and outward is unduly free in the dislocated leg particularly with the leg slightly abducted. Then as a final resort the x-ray film will show the femoral head outside the acetabulum and the acetabulum incompletely developed.

In an older child that has reached the walking stage the detection of a dislocation is very much easier as I will demonstrate on this patient. First with the child standing you will notice that the right leg is rotated outward and the foot points out. Looking at the child from behind you will notice a difference in contour in the iliotrochanteric region—the right

but in many cases, regardless of most careful replacement, redislocation will occur. In my experience, it is quite as apt to be a dislocation anteriorly as posteriorly, especially in cases that are put up in plaster with the leg rotated out and abducted to 90 degrees in the frog leg position. This latter complication is undoubtedly due to progressive anterior torsion of the neck of the femur.

In addition to these pathologic changes in the bony structures, remember we have a capsule that is stretched and distorted, and possibly with a lumen so small it prevents passage of the femoral head into the acetabulum. These changes in the soft parts do not show in the x-ray films but when reduction is attempted the obstacles to reduction are encountered and an easy case may turn out to be very difficult or impossible.

A word further about pathology. I have here two x-ray films—this one in a child about five years of age shows a distinct but shallow depression where the acetabulum should be (Fig. 6), the other, in a child of seven, shows a very well developed acetabulum, although the shelf is irregular in contour (Fig. 1). On account of the depth and better roof of the acetabulum in this older case we might naturally suspect that it was a parturitional displacement occurring at birth. You will notice that the head too seems better developed and better shaped than most congenital dislocations at that age, but no one knows of any traumatism occurring at birth, and the diagnosis was not made until the child had walked for five years.

Treatment—There has been a great deal of discussion in the past ten years as to the relative merits of closed and open reduction for congenital dislocations of the hip. Some advocate open operation in all cases whereas others maintain that under certain ages the closed method is preferable, being safer and insuring just as good results. In view of Putti's report showing 95 per cent favorable outcome by reduction alone in cases under three years it is very evident that the success of a closed reduction depends on the age of the child more than on any other factor and that early diagnosis is the most important single consideration in the entire subject.

One finds considerable difference of opinion among the various clinicians. Gill removes the cast after four months,

although the child may have never walked. The capsule is elongated and flattened, and as time goes on becomes constricted and in many cases, where open operation has been done, the operator has reported finding the capsule adherent to the ilium above the acetabular border. The ligamentum teres is stretched and flattened and may even be entirely absent. The anterior torsion is actually a twisting anteriorly of the femoral neck and the trochanteric region. On account of the position of the head against the side of the pelvis, the anterior torsion grows progressively worse with walking producing an outward rotation of the leg and becoming a serious obstacle to maintenance of the reduction after it has been accomplished.

Although it is well known that the head and neck do not develop outside of the acetabulum it is also true that when reduction is effected in a child of seven years or more, serious pressure changes which destroy the head often result.

The oldest case which I have ever reduced was in a girl twelve years of age. The acetabulum looked so good and femoral head so well developed that I decided to attempt reduction. She was kept in bed previously with 15 pounds' traction on the leg for three weeks to stretch the tendons and soft tissues and I was quite surprised at the ease with which the reduction was accomplished, but, after the cast was taken off and the leg was brought down and the patient allowed to walk, the head of the femur underwent gradual atrophy and destruction with absorption of the head and upper part of the neck, and finally almost complete loss of motion in the joint.

not even been thought of

In many cases after reduction, especially in younger children the acetabulum gradually becomes deeper the femoral head undergoes markedly improved development and the

trochanter, the thumb in the groin. The leg is held in external rotation and abduction and with the knee sharply flexed it is brought up to the side of the body. The patient is now ready for the attempt at reduction. Pressure is made downward along the axis of the femur and backward on the knee while the other hand exerts upward force with the fingers on the trochanter and then continuing this pressure and position the leg is slowly rocked back and forth in a short range of circumduction. After a short time the knee is slowly brought

be palpable, audible, or even visible, though in the older cases the head seems to "ooze into place". If the characteristic snap is not felt the maneuver is repeated several times until it does occur, and is usually repeated at least once after it has snapped. When the dislocation has been reduced, the depression in the groin disappears as the head can be felt and by holding the leg in 90 degrees' abduction one cannot extend the flexed knee much beyond right angles because the short hamstrings prevent it. This sign is frequently used as a test of reduction. The next step is the application of a spica cast, covering the pelvis and the leg as far as the ankle, in the position of right angled abduction of the thigh and flexion of the knee. The cast is left on from two to three months and is then changed without using an anesthetic. In the second cast the leg is brought down to 45 degrees' abduction and rotated internally a bit. Sometimes after this change, it is possible to put the child astride a kiddy car so she may begin to use the leg. After two months a third cast is applied, again decreasing the abduction and external rotation. Usually after the third cast she may begin to walk. This last cast is again used for about two months and when it is taken off the leg is in slight abduction and external rotation while motion in the hip joint is limited. Physiotherapy can be used at this juncture to mobilize the leg and occasionally it may be necessary to manipulate the leg more vigorously under anesthesia, however, if left to natural means, i.e., walking the youngster will solve her own problem.

Closed reduction is not without certain risks. In the first

allows the child to walk and if redislocation occurs he advises open operation, Steinbier finds that only 14 per cent of cases come under observation before one year old and 36 per cent after five years of age, the period of retention in plaster varies from two to ten months, some prefer a shelf stabilizing operation after nine years without any attempt at open reduction, however my personal conviction is that all patients regardless of their age may be improved by some method and—in general I favor the following plan

Abduction Method—In 1929 Putti reported the cure of 24 cases by simple gradual abduction without traction in children under one year of age and stressed the point that treatment must be begun before the child has walked. Coonse has modified this method by the use of a combination traction abduction splint and has been able to secure reduction in cases five to seven years old. A simple method is that of Freiberg who applies straight leg casts from toes to gluteal folds and incorporates turnbuckles which produce gradual painless abduction. Suffice it to say, that in children under the age of walking, one of the several abduction methods may be de

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and Ridlon and made popular in the United States as the

the child is anesthetized she is placed on her back and with the assistant holding the pelvis the affected leg is widely abducted while the operator gently massages the adductor muscles with the palm of the hand (Lorenz would forcibly tear these muscles by vigorous sharp blows with the side of his hand)

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trochanter the thumb in the groin. The leg is held in external rotation and abduction and with the knee sharply flexed it is brought up to the side of the body. The patient is now ready for the attempt at reduction. Pressure is made downward along the axis of the femur and backward on the knee while the other hand exerts upward force with the fingers on the trochanter and then continuing this pressure and position the leg is slowly rocked back and forth in a short range of circumduction. After a short time the knee is slowly brought around away from the side by extending the range of circumduction and usually just before 90 degrees abduction is reached the head will be felt to snap into the socket. This snap may be palpable audible or even visible though in the older cases the head seems to ooze into place. If the characteristic snap is not felt the maneuver is repeated several times until it does occur and is usually repeated at least once after it has snapped. When the dislocation has been reduced the depression in the groin disappears as the head can be felt and by holding the leg in 90 degrees abduction one cannot extend the flexed knee much beyond right angles because the short hamstrings prevent it. This sign is frequently used as a test of reduction. The next step is the application of a spica cast covering the pelvis and the leg as far as the ankle in the position of right angled abduction of the thigh and flexion of the knee. The cast is left on from two to three months and is then changed without using an anesthetic. In the second cast the leg is brought down to 45 degrees abduction and rotated internally a bit. Sometimes after this change it is possible to put the child astride a kiddy car so she may begin to use the leg. After two months a third cast is applied again decreasing the abduction and external rotation. Usually after the third cast she may begin to walk. This last cast is again used for about two months and when it is taken off the leg is in slight abduction and external rotation while motion in the hip joint is limited. Physiotherapy can be used at this juncture to mobilize the leg and occasionally it may be necessary to manipulate the leg more vigorously under anesthesia however if left to natural means i.e. walking the youngster will solve her own problem.

Closed reduction is not without certain risks. In the first

place it may be unsuccessful, the head gradually redislocating. Anteversion may take place to such a degree that dislocation is inevitable or it may occur in a manner whereby the femoral neck rides against the projecting roof, a so called "anterior transposition" which in years past was considered a fair result if complete replacement was not secured. Today this condition may be converted into a completely successful result if recognized and treated. Colonna and Krida recommend changing the plaster fixation from one of external rotation to internal rotation, the knee is held flexed and of course projects laterally from the body. If the head has been replaced the position is maintained for three months after which a manual osteoclasis (or open osteotomy) is done in the lower third of the femur, permitting a rotation of the knee and lower leg back to their normal position and thus correcting the anteversion of the head and neck. If reduction is attempted in older children or performed roughly, a fracture of the femoral neck may result. Furthermore it is not uncommon to see Legg Perthes' disease develop in later years in a hip joint presumably injured during the process of reduction. I have already stated my experience in a child of twelve years of age where a closed reduction produced so much pressure in the hip joint that the structure was completely destroyed.

Open Reduction.—It is the consensus of opinion that open reduction should be resorted to when closed reduction has failed and only between certain ages. Colonna has devised an ingenious arthroplastic technic in which he attains his best results between the ages of three and eight. The method involves two stages, first in which the femoral head is pulled down with traction, tenotomy or periosteal stripping of the gluteal muscles and secondly an open operation in which the elongated capsule is severed close to the head the retained portion being sewed together to cover the head while a capacious socket is reamed out at the anatomical site to receive it.

Other open methods may be used, but all imply opening the capsule, removal of cartilage and fibrous tissue from the acetabulum and usually section of the shortened contracted muscles in order that the head may be skidded into the socket. As a rule a cast is applied in abduction of 45 to 50

degrees and kept on from three to four months. Operative reduction, as a rule, is not to be recommended after eight years of age.

Irreducible Dislocations—In children over eight years of age the building of a bony shelf advocated by Dickson and others offers an excellent palliative measure. The shelf is constructed as close to the capsular attachment as is possible and the buttress which forms on the side of the ilium aids the development of a natural process for in many cases of un reduced dislocations a false socket is in process of formation above the normal anatomic site. While the leg will be shorter than its fellow stability is secured there is freedom from pain and the later development of arthritic spurs all of which make this operation a very satisfactory procedure.

For the older adult case especially when the head is very high a subtrochanteric osteotomy with the abduction of the lower fragment gives the best results. Shanz divides the femur at the lower border of the pelvis and angles it so the upper fragment is applied to the side wall of the pelvis the lower fragment being abducted to parallel the long axis of the body. This immediately gives a stable position and improves immensely the function of the leg and hip. McMurray has devised a similar osteotomy and the Lorenz bifurcation operation is sometimes used. In the latter the femur is divided obliquely upward and inward the limb is abducted and the upper end of the lower fragment is inserted into the acetabulum. After union the upper end of the femur is Y shaped with a bifurcated end on which the pelvis rests.

In the following 4 cases which I am going to present you will see the indications for these various procedures. In the first case for instance this girl was at the upper age limit for closed reduction still the actual maneuver was easy and the result has been thus far eminently satisfactory. Please note in this case the rapid development of the capital epiphysis after replacement and functional use of the joint. The youngest child had such marked anteversion that redislocation occurred yet we were able to convert this poor result into a good one by doing an osteotomy of the femur.

In the third case a very satisfactory shelf has been formed so close to the original socket that almost normal function has

resulted. Probably no case required such careful study and patient long care as the last. In this instance we took advantage of three methods after closed reduction failed, first the erection of a bony shelf over the head, second, the conversion of an anteversion into a normal position and thirdly, an osteotomy which insured a stable hip should the bony shelf and shallow secondary acetabulum fail.

Case I—D. D. aged seven. This child was first seen in January 1935. She walked with a characteristic limp and x rays showed a congenital dislocation of the left hip joint (Fig. 1). The family had been told that the limp



Fig. 1—Case I. Dislocation in seven year old girl with an irregular but favorable looking acetabulum.

which was noticed when the child first walked would be outgrown so no treatment has been instituted. After a period of traction on the legs in April 1935 a closed reduction was attempted. This proved difficult and although

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1935 this last cast was removed and it was found that the head had remained firmly in the socket and already free motion was present. The patient was discharged and in January 1936 x ray films (Fig. 2) showed that the replacement had been maintained and the child was walking normally and appeared perfectly well. The last examination was made in April 1938 (Fig. 3).



Fig. 2—Case I After closed reduction



Fig. 3—Case I Three years after reduction Note development of femoral head and joint

At this time the right leg measured 26 $\frac{1}{2}$ inches, the left 26 $\frac{3}{4}$ inches. Internal rotation was slightly limited as was abduction while the other motions were of average normal range. Bryant's line right 1 $\frac{1}{2}$ left 1 $\frac{3}{4}$. There was a moderate atrophy of the calf. However the case presents a very satisfactory result. If you will watch this youngster walk I doubt if you could tell which hip had been affected.

Case II—C. B. aged one and one half years. The parents had noticed a peculiar walk and brought her to the Evanston Hospital out patient department in December, 1937. The right leg was 1 cm short and the child showed all the characteristic signs of a posterior congenital dislocation. Closed reduction was easily accomplished in January, 1938 and the position



Fig. 4—Case II. After second reduction with leg in extreme internal rotation maintained in 90 degrees' abduction and external rotation. Changes of casts

A second closed reduction was performed easily by strong internal rotation of the leg. On x ray (Fig 4) it was seen that a satisfactory replacement had been made. It may be noted that the rotation is maintained by extending the plaster to below the knee, which is flexed at right angles. This cast was used until July, 1938 when the portion from the knee down was removed and an open osteotomy performed. The lower leg was externally rotated and after the incision had been closed the cast was extended to the foot to hold this new position. In the x ray made subsequently (Fig 5) one notes that the replacement of the head is still maintained while in the lower third the



Fig 5—Case II. Osteotomy of lower third of femur to correct the leg and yet maintain the replaced femoral head.

osteotomy is visible with a normal relationship of the knee joint. This last cast was removed in September, 1938. The child has made a good recovery.

Case III.—B. C., aged five years. The patient was first seen in the Evanston Hospital out patient department in February, 1933. The complaint was a peculiar gait, marked by a limp on the right side. On examination a dislocated right hip was found and on x-ray the diagnosis was confirmed with the added evidence of dislocation of the left hip as well. During the same month a closed reduction was performed on both hips with replacement and fixation in a double spica in wide abduction. The subsequent course with changes of casts every two to three months was uneventful. At the conclusion of the treatment the usual stiffness and abduction were evident and persisted for about eight months. Gradually a more normal position of the legs appeared, but the child still had a limp on the right and x-ray examination proved that this joint had redislocated. Later another attempt at closed reduction on the right failed.

At this juncture the family finally consented to an open operation (Fig 6), and in June, 1936, a shelf operation was performed on the right hip. Through a Smith Petersen incision a semicircular piece of bone was outlined above the acetabulum and turned down from the outer plate of the ilium. The upper border was cut free and the plate forcibly broken down with the



Fig. 6—Case III. Radiograph showing a reduction of the left hip and a redislocation of the right hip. Note shallow acetabulum on the right.



Fig. 7—Case III. Two years after a shelf operation on the right hip. Note that the shelf has been placed at a site which practically restores the anatomical socket.

fractured lower border left attached. The shelf thus formed was secured by V shaped wedges cut from the crest of the ilium. These wedges were

forced into the denuded ilium above the shelf. The leg and pelvis was then fixed in a plaster spica for six to eight weeks. After recovering a well

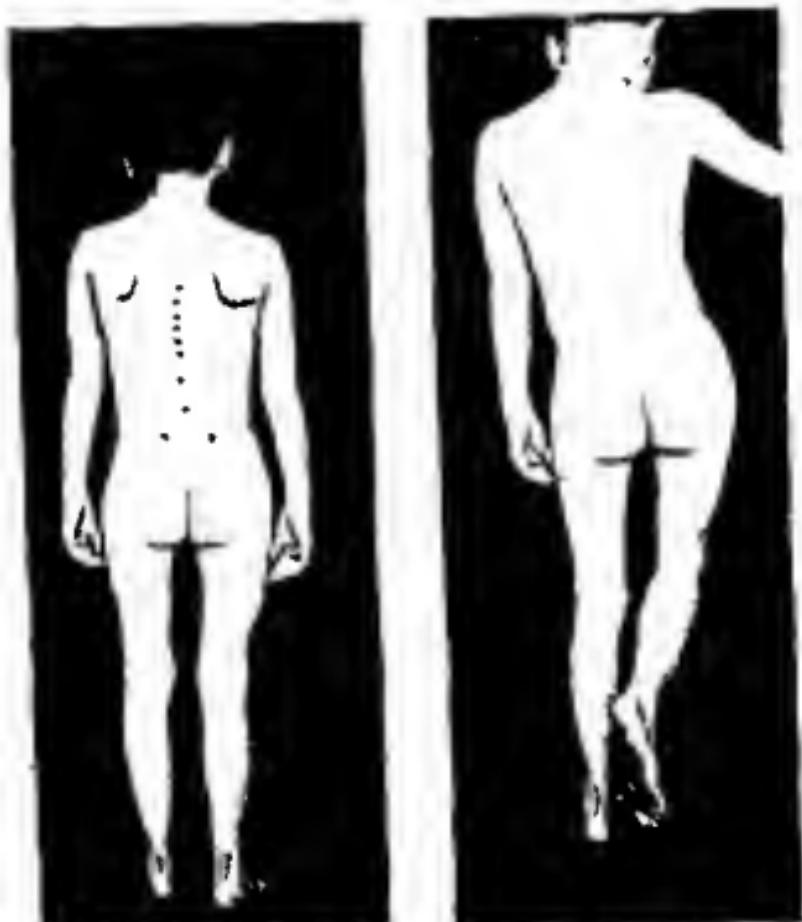


Fig. 8—Case III. After closed reduction on left hip and shelf operation on right hip.

developed acetabular roof was formed (Figs. 7-8) and the child now walks quite well and without a limp.

Case IV—F. S. aged five and one half years

This patient walked at nineteen months with a limp and complained of pain but no diagnosis was made until July 1925. A manual reduction was performed and the usual cast immobilization followed. The result was considered to be partially satisfactory. Anteversion of the neck was present and the child seemed to have a fairly stable joint in the anterior transposition. However, when she was seventeen years old the hip became increasingly painful and a bad limp appeared. On examination it was found that any previous apparent stability had been lost and the hip joint was completely dislocated with complete anteversion of the head and neck of the femur (Fig. 9).



Fig. 9—Case IV. Anterior torsion of the femoral head and neck eleven years after closed reduction.



Fig. 10—Case IV. Radiograph made after shell operation in 1937 and with leg held in extreme internal rotation.

After a preliminary period of traction on the leg an open operation was done in November 1936. The Y ligament, adductor muscles and other con-

tracted tissues were divided and a bone shelf was built above the femoral neck. After an ample immobilization and recovery, walking was again permitted and in the ensuing months the leg had definitely greater stability but was painful. Before attempting any further operative work, the leg was held in extreme internal rotation and an x-ray was made (Fig. 10). This film showed the femoral neck with the head in a shallow, false acetabulum above the anatomic socket. A second operation was performed in June 1938 through a linear incision over the great trochanter. The femur was divided below the trochanters, the upper fragment was mobilized by a Steinmann pin in the trochanter and then strongly rotated internally while the lower frag-



Fig. 11.—Case IV. Healing osteotomy in 1938 showing abduction of lower fragment and maintenance of upper fragment in internal rotation. The head is in a false acetabulum under shelf.

ment was abducted. Fixation was secured by a plaster spica, which also secured the protruding pin. The cast was removed at eight weeks and you will see she has finally secured a painless stable joint.

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SURGICAL TREATMENT OF FLAT FEET:
INDICATIONS AND TECHNIC

THE title of this demonstration implies perhaps the open operative methods of correcting flatfoot deformity. However, any discussion of this kind must also include the anatomy, pathology and physiology of the foot as well as the relationship to associated foot conditions.

The first consideration should be a classification of the types involved, though not necessarily a rigid one. It should serve as a basis for a mutual understanding.

Let us, therefore, take up the subject under the following headings. For many years orthopedic surgeons have divided flat feet into two groups, namely, the flexible and the rigid types, however, one must qualify these groups further according to etiology as

- 1 Static
- 2 Congenital
- 3 Traumatic
- 4 Paralytic
- 5 Arthritic

Although it is a primary essential to the understanding of foot disorders I shall not bore you with a review of the anatomy of the foot, except in so far as I may refer to it as a matter of clinical application.

One does need to consider function, and to quote Shands,¹ "The function of the foot is (1) to serve as a support for the weight of the body and (2) to act as a lever in raising

¹ A. R. Shands Jr.: *Handbook of Orthopedic Surgery* C. V. Mosby Co.
Publishers

and propelling the body forward in walking and running. The muscles of the leg supply the power and the heads of the metatarsal bones serve as a fulcrum on which the weight is lifted. The foot contains two main arches formed by bones and supported by ligaments and muscles. A normal degree of elasticity in these arches is necessary for the proper function of the foot."

Static Flatfoot—Static foot disorders leading to the development of flat feet are very common. In children the relaxed weak foot seems to be on the increase. This may be in part due to the fact that walking is done a great part of the time on hard, unresilient surfaces. Our modern floors, walks, and pavements represent this factor. Another is the increase in growth and weight of the new generation of children whose bodies show added stature and weight, often developing with such rapidity that the supporting ligaments fail to keep pace. In keeping with the general development, the feet are longer and larger. Abnormally long arches predispose to foot strain and the development of flat feet. Many of these youngsters will show a normal appearing arch at rest, yet when weight is borne the long arch disappears, the foot pronates in valgus and the tuberosity of the scaphoid is unduly prominent. In adults excessive weight in time will gradually break down the best constructed foot, and when combined with the natural changes of the years, sooner or later foot strain and then flat foot may develop. Occupational strain where long hours on the feet are necessary, notoriously produces flat feet as witness the facetious reference to the policeman as a 'flatfoot'. Long illness with resulting loss of muscle power and relaxation of ligaments frequently is a factor.

Pregnancy introduces a physiologic relaxation of the pelvis why not of the feet as well. As a matter of fact it does. Repeated pregnancies often leave relaxed and flat feet in their wake. The human race while built alike varies exceedingly in its individual makeup, and some unfortunate people are so constructed that these static causes are unavoidable. Thus inadequate muscle and ligamentous structures may be responsible factors in the development of flat feet.

Incorrect shoeing while not the important cause today as it was some years ago, is, nevertheless, a factor to be reck-

oned with In fact the army on relief which among other things has had to accept cheap, poorly made shoes will in due time face us with a flood of old time deformities The case which I am presenting to you today illustrates the point

Case I—H F aged fifty two years. This patient was a Hollander who had no foot trouble while wearing the typical Dutch wooden shoes but when about eighteen year old he found a job in the city and indulged himself in his first leather shoes. These he remembers were ill fitting and short but owing to his pride he continued to wear them and then began a series of deformities which caused a progressive disability. At the time of entrance in the hospital May 14 1937 he had bilateral bunions more severe on the left foot where the great toe overlapped the second toe. He walked with a typical flat foot or heel walker's gait. Both the long arch and the transverse arch were lost and the feet were so troublesome he was almost totally disabled. The operation (MacBrades' technique) consisted of a $2\frac{1}{2}$ inch incision between first and second metatarsals which were then separated to expose the lateral sesamoid bone. This bone was removed. In the second step transplantation of the adductor hallucis from its attachment to the sesamoid and the base of the proximal phalanx was made to the head of the first metatarsal. This is done in order to shift the muscle pull from the phalant a factor in producing the valgus position of the toe to the first metatarsal bone. After removing the retractors between the metatarsal bones the skin was retracted medially to expose the bursa and exostosis over the bunion. The bursa was removed and the exostosis trimmed off with a sharp chisel. Closure of the wound was then effected and the foot immobilized in a plaster cast. A similar procedure was followed on the right foot.

The result on the right foot was excellent but on the left adhesions and osteophytes developed at the joint which produced a hallux rigidus. So on July 6 1937 the left foot was again operated. It was apparent that the claw toed deformity could not be relieved without a more radical procedure. Re-

out great pain

Although a resection of $\frac{1}{3}$ inch of the first metatarsal was done at the last operation it was necessary later to perform a third operation to resect a larger section of the first metatarsal head since the toe joint had filled with adhesions and had produced a fibrous ankylosis. This development proves that to avoid ankylosis a generous resection of the first metatarsal head is always necessary.

Finally the patient was through with these several operations and now I shall ask him to walk for us in his bare feet. Walking without shoes is a test alone but you will observe that he has a fairly normal gait the hallux valgus is corrected and with felt support in his shoes he is quite comfortable. On the screen I have an x-ray of the left foot before operation (Fig. 12) and the second x-ray (Fig. 13) shows the condition at the present time.

Congenital Flatfoot—As might be expected, the possibilities here are infinite but two examples of the more common types will be shown. The congenital flatfoot or mallet foot is well known and easily recognized after walking begins. Some of these cases are due to the excessive relaxation of muscles found in the club foot designation talipes calcaneo-valgus. At birth these feet are found with heel cord length



Fig. 12—Case I. Severe hallux valgus and contracted toes—a shoe deformity in this instance.

ened and the dorsum of the foot resting against the lateral surface of the leg. The posterior muscles are lengthened while the anterior flexors are shortened. If not recognized and treated by corrective casts and manipulation these feet develop flatfoot deformity. Other instances in which there are inadequate muscle and ligamentous structures will also develop a flatfoot when weight bearing begins. The first case is one in which there is a history of flatfoot present since infancy.



Fig. 13—Case I After resection of metatarsal heads M 1 2 3 4

Case II—M. U. aged fifteen years. This girl has always had painful feet as long as she can remember. At ten she had infantile paralysis but there was no paralysis of the legs or feet. The pain was located along the medial aspect at the level and up the back of the leg. The feet were flat and the astragalo-scapoid joint was extremely prominent so that a line drawn in the long axis of the os calcis instead of passing straight forward through the foot would pass sharply out into space at the metatarsal joint. Both feet were similar in appearance and you will note a curious curved inthrust of the forefoot present in the x rays as well. This case was obviously one in which any substantial correction required an open operation performed first on the left foot on December 13, 1937 and three months later on the right foot. The procedure consisted of an astragalo-scapoid arthrodesis followed by manual correction and plaster immobilization. On operation it was noted that the astragalo-scapoid ligament was tremendously hypertrophied proving that it was the only strut which secured the joint. The head of the astragalus was completely dislocated and its cartilaginous surface was entirely out of contact with the cartilage of the posterior surface of the scaphoid. The head and neck of the astragalus was resected and followed by a denudement of the cartilage from the posterior surface of the scaphoid. After removing the cartilage from the resected head and reshaping it the bone was tightly packed back in the cavity. Enough mobility of the long arch was then secured to reshape it and a plaster

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the exact appearance. In either, malfunction is present and the same treatment is indicated. Sever recommends removal of the accessory bone or enlarged tuberosity and combines with it an astragaloscapheoid arthrodesis. Kidner on the other hand has stressed a faulty attachment of the posterior tibial muscle which by changes in leverage interferes with the normal elevation of the longitudinal arch.

This patient presents a typical condition in only one foot and as the x ray shows there was an accessory scaphoid bone.



Fig. 15—Case II. Photograph after operation showing present foot position and metatarsus varus.

(Fig. 16) I have mentioned the symptoms and the examination disclosed an accompanying flatfoot deformity.

Case III—J. S. aged nineteen years. On January 27, 1938 an operation using the Kidner technique was done through a 3 inch incision at the metatarsal joint. Kidner states the posterior tibial tendon is expanded to a wide heath as it passes over the scaphoid tuberosity. In this case the tendon attachment was freed from the bone over its superior and medial surface but the inferior attachment was left. It was then possible to roll the expanded flattened tendon into a rounded cord that could be more firmly secured by ligamentous strips which crossed it so that the direction of pull was under the scaphoid tip. Although the x ray shows an accessory bone no definite cleavage was found.

cast was applied to hold this new position. After two weeks the cast was removed, the arch was again reshaped and a new plaster cast applied. This was left on for six weeks.

It is frequently necessary to lengthen the tendo achillis in order to build up the long arch after an arthrodesis is performed but it was not done here. You may observe that the metatarsal joints in this patient are still prominent but function has been vastly improved. Observe how she walks. Perhaps the best answer of all is her own statement that last week for the first time she was able to dance. Figure 14 shows x-ray taken before operation and Fig. 15 shows the result after operation.

A second and very common congenital variation is seen in patients who find that the tuberosity of the scaphoid pro-



Fig. 14—Case II. After arthrodesis at astragaloscapheoid articulation. Congenital flatfoot.

jects beyond normal extent and is accompanied by a flatfoot. Parents will refer to it occasionally as a double ankle bone referring to the scaphoid and the malleolus. In the case which I wish to show you the patient complained that the prominence rubbed against her shoe and she was unable to get fitted comfortably. This variation has been frequently noted in the literature as accessory scaphoid (Sever), as prehallux (Kidner), or to give its anatomic name, as *os tibiale externum*. The presence, however, of this prominent bone on the surface does not necessarily mean that the accessory bone is always present, for in many instances an overly large tuberosity gives

the exact appearance. In either, malfunction is present and the same treatment is indicated. Sever recommends removal of the accessory bone or enlarged tuberosity and combines with it an astragaloscaphe arthrodesis. Kidner on the other hand has stressed a faulty attachment of the posterior tibial muscle which by changes in leverage interferes with the normal elevation of the longitudinal arch.

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and the excessive projection was removed with a chisel in the same fash on that an enlarged tuberosity would be resected. Following the operation and healing of the wound physiotherapy was begun. The first complaint was relieved by the bone removal but the second and more important feature was the gradual development of an arch. The operation was eminently successful as the patient's walking gait and story now disclose. On the screen are the x rays taken before and after operation (Figs. 16-17).

Morton has described an hereditary condition in which there is a short first metatarsal bone, with a posterior place



Fig. 16—Case III. Radiograph before operation. Note os tubercle externum

ment of the sesamoids. This very naturally leads to a disturbance in the foot balance foot strain and flatfoot deformity. He designates the variation as a metatarsus atavicus. A second cause of foot strain due to the persistence of early evolutionary changes is the hypermobile first metatarsal segment which Morton also insists is a common cause of foot strain. Clinically, the first metatarsal segment is abnormally

mobile especially at its base and the x ray shows a separation from the adjoining second metatarsal extending back as far as the articulation of first and second cuneiform bones with the scaphoid.

Traumatic Flatfoot—A frequent cause of flatfoot either of the relaxed, or more commonly of the rigid type is injury



Fig. 17—Case III After operation with removal of accessory scaphoid

from industrial or motor accidents. One need not mention the many possibilities but I will show one of these cases.

Case II—B. S. aged nineteen years. The right foot was badly crushed and lacerated in a motorcycle accident in August 1937. Multiple compound fractures of the forefoot involving principally the second, third and fourth metatarsal heads. The foot finally healed with stiff claw toes with the func-

tion of the forefoot absolutely lost and secondary flatfoot changes in long arch. The bone healing following the extensive mutilation proceeded with a fusion and distortion of the second and third metatarsal heads. At operation on June 27, 1938, it was necessary to resect the third metatarsal and the first metatarsal heads. Following the operation a long period of physiotherapy was begun. This treatment furthered the mobilization of the forefoot so that at present the patient walks without a limp. Observe that he has developed a fairly normal looking forefoot and the long arch is adequate. Naturally this type of malfunction was in the rigid flatfoot type and it was corrected largely



Fig. 18—Case IV. Radiograph with multiple comminuted fracture and dislocations of forefoot.

by operative intervention and physiotherapy with subsequent return of function to the forefoot and long arch.

Paralytic Flatfoot—Infantile paralytics with the muscle imbalance which follows represents the best example of paralytic flatfoot deformity. The frequent paralysis of the anterior and posterior tibial muscles must obviously result in a flatfoot deformity. Braces and night splints protect the foot for the time being but eventually the strong pull of the eversion muscles produces a valgus deformity. It is the

occurrence of this particular deformity that has resulted in the highest development of technic for arthrodesis of the tarsal joints. The first constructive attempt concerned muscle transplantation, but subsequent study of cases confirmed the necessity of adding to the procedure an arthrodesis of the ankle. The basic operation consisted of a subastragalar arthrodesis, to which is added individual stabilization of other tarsal joints as the particular case demands. These stabilizing operations are now well known under the names Hoke, Ryerson, and



Fig. 19—Case IV. Radiograph after operation for resection of bone fragments and metatarsal heads.

Dunn. Any or all of the aforementioned conditions may result, if untreated, in a rigid flatfoot.

Rigid Flatfoot—Rigid flatfoot is of rather uncommon occurrence. It can be the end result in a case of untreated flatfoot although at first merely representing a splinting of the foot by muscle spasm. In the end, however, the rigid valgus and everted position becomes fixed with structural changes in bone, muscles and ligaments.

When foot strain is present for a long period of time, there

are definite changes that take place. Ligaments become relaxed and at points of stress notably at the astragaloscapoid ligament tremendous hypertrophy takes place to accommodate for the unusual strain. It is characteristic to find soreness on pressure over muscle and ligamentous attachments and in time joint strain produces periarticular swelling with an inflammatory exudate. Osteophytes are found along the joint margins and fibrous adhesions develop. The peroneal muscles stand out like whip cords and it is not an uncommon practice to lengthen them. Occasionally it is necessary to lengthen the tendo achillis as well. Treatment is always directed toward the conversion of the rigid foot into a better functional position. This is done under general anesthesia with gradual manipulation of the foot into supination. It may be necessary to use a Thomas wrench to effect this change however a more gentle manipulation even though repeated is advisable. Whatever correction is obtained is held by fixation in a plaster cast. Walking may then be permitted at the discretion of the surgeon in the plaster boot to which there has been attached one of the various forms of walking irons. The usual period of fixation is from one to three weeks when manipulation may either be repeated or the patient allowed to walk in a corrected shoe. Shoes are now available having excellent support in the form of a steel shank and a built in leather support for the long arch. It is sometimes necessary to make modification of this support with shaped felt pads. In some instances it is desirable to take a plaster model of the recently supinated foot and have either steel or duralumin foot plates manufactured from the mold. These are worn indefi

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feet. Fractures of the tarsal and metatarsal bones if unproperly splinted may cause such structural changes that the longitudinal arch is lost. The painful flatfoot which results is best treated by arthrodesis either by the Ryerson triple arthrodesis or by wedge osteotomies of the tarsus.

Arthritic Flatfoot—Perhaps the most difficult type of rigid foot to treat is that incurred in the course of a hypertrophic arthritis. Occasionally some improvement may be

obtained with mild manipulation and fixation in a plaster boot, and arthrodesis is sometimes used, however, the prognosis is not good. With the general loss of motion and extensive involvement of the joints, a long period of rest offers the best solution, and even when the inflammatory process has subsided, the final result is too often serious impairment of function. This situation does not apply, however, to localized hypertrophic joints. Hallus valgus or hallus rigidus, both of which may cause flattening of the arches are not necessarily of arthritic origin but may result from arthritis.

In hallus rigidus, dorsiflexion is lost, and the subsequent change in the foot balance necessary to permit walking can produce a flatfoot. The first metatarsal head is enlarged and irregular with hypertrophied bone. The joint space is diminished and while the condition is indistinguishable in the elderly person from a hypertrophic arthritis as a rule it is caused by an injury. The condition is progressive. In time hallus valgus produces extensive hypertrophic changes about the metatarsal head. Both of these conditions may be corrected by operation either by shaving down the head with a chisel or in many cases it may be necessary to remove the entire head interposing the capsule in the space as is done in the Mayo operation. There are as well several operations in which a wedge of bone is removed from the neck of the metatarsal quite close to the head (Jones). The operation of choice depends I think on the individual case. I am not proposing here any discussion of bunions or operations for their relief but merely calling your attention to purely local conditions where bone hypertrophy has taken place and which are associated with our general subject.

Physiotherapy—One of the most important features of treatment has been left for the last because of its importance and because of its general application. Practically all of these conditions subsequent to operation require physiotherapy in its various forms. Hydrotherapy in particular offers distinct advantages in promoting a return to normal. These feet are often stiff and sore with the impaired circulation and function which must be gently and patiently coddled until improvement is obtained. For relief of pain, soreness and tenderness there is nothing superior to the hot wet pack which relaxes

the muscle spasm and stimulates circulation. This is followed by massage and later active and passive motion may be instituted. The whirlpool bath or needle spray is an excellent stimulant. Most orthopedic surgeons routinely employ the contrast bath of alternate hot (three minutes) and cold (one minute), especially for the less severe types.

Of course, heat may be given in other forms as for instance radiant heat infra red rays and diathermy or inductothermy. The latter represents a powerful aid which must be employed with caution for joints are often near the surface not too well circulated at best and care must be observed to avoid overheating.

However, without the use of physiotherapy, the surgeon would find his operative efforts of little avail to correct these

function. The stress placed on this particular therapy varies in the hands of different men. However it is beside the question since once better function develops the patient himself will inevitably resort to exercises as a perfectly natural process.

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TREATMENT OF LOW BACK PAIN

IN adult life low back pain is one of the commonest complaints about which the orthopedic surgeon is consulted. It has almost unlimited possibilities of interpretation. A simple classification on a definite pathological or organic basis cannot be obtained but backache can be divided into two rather wide classes (1) in which the pain is a symptom of some disease not definitely connected with the spine and (2) in which it is in the spine itself.

Far too many patients with backache have been treated for sciatica or lumbago without first having had a thorough physical examination. Any patient seeking treatment for low backache requires a complete and thorough history and physical and x-ray examination. Such a history and examination will in the majority of cases lead to the discovery of the causative pathology. Rational therapy can be instituted and carried out only when the pathology is known.

Pain in the low back may be referred from diseases of the viscera. For that reason all gynecological, genito-urinary and neurological conditions should be carefully investigated and eliminated. Low back pain is severe and constant early in acute poliomyelitis. It is present to a marked degree in cord tumors. Tabes and disease of the cord itself must be ruled out. During the past three years 4 patients who entered our clinic because of low back pain were found to have negative orthopedic and x-ray findings. Neurological examination revealed multiple sclerosis in each case.

Metastatic disease of the spine causes extreme pain. This pain is not dependent upon posture or motion in the spine and it is not relieved by rest on a rigid bed, by casts, braces

or any of the therapeutic measures as is the pain from any other cause. A patient with a metastatic lesion in the spine is surely entitled to any relief that can be given. Cordotomy affords relief in many cases. In some 4 or 5 cases we have done spinal fusion operations, using a large tibial graft. In each case relief from the pain was marked and the patient's remaining span of life was much more comfortable. Of course, the patient's family must be told that the procedure is only palliative and that by no means will it arrest the course of the disease or prolong life.

Backache and sciatic pains are very often due to the presence of an actual osteoarthritis of toxic or infectious origin. They may also be due to certain back straining occupations or errors in posture. When an inflammatory process or trauma is added to a mechanically unstable joint, pain and disability follow. The pain may come on suddenly or insidiously and may radiate down one or both sciatic nerves, the gluteal nerves or down the front or sides of the thighs. It may be so severe as to be immediately disabling as in sudden twists of the body or when a heavy object is lifted. In many instances where there has been an injury, such as a sprain, the pain does not appear until a day or two later. The reason for this very common occurrence is perhaps best explained by an effusion of blood and lymph which becomes organized and forms scar tissue and adhesions around the site of injury. As a result of this there is pain and limitation of motion when these tissues are stretched. The pain lasts a variable length of time; it is aggravated by excessive movements and heavy labor. It is worse after a day of activity but is relieved by rest. Unless proper rest of the damaged tissues is instituted early inflammatory changes occur and the pain becomes practically continuous (Fig. 20). By some this condition is regarded as a myofascitis of rheumatic origin. If the x-ray shows arthritic changes they are due either to disease or long continued strain or both.

Many cases of disease and strain of the sacro-iliac joints occur but the lumbosacral joint is more often the site of the

working diagnosis. Pain along the course of the sciatic nerve occurs in both sacroiliac and lumbosacral lesions. If the



Fig. 20.—Patient with sacroscoliosis. Recovery without operation



Fig. 21.—x Ray showing body of fifth lumbar vertebra overhanging the sacrum
pain is unilateral either may be involved. If bilateral the lesion is usually in the lumbosacral joint. Gaenslen's sign is

very reliable in arriving at a diagnosis of sacro iliac involvement

There are many anatomic variations in the lower spine which may at times produce pain and disability. Among these are spondyloolisthesis, an abnormally oblique lumbosacral angle (Figs 21, 22), sacralized fifth lumbar transverse process (Fig 23), spina bifida occulta, abnormal articulations pronounced hollow back and static factors. Flat feet and short Achilles tendons produce fatigue of the lumbar muscles and often a severe back strain. Poor sitting posture in a



Fig. 22.—Same patient as Fig. 21 after spinal fusion. She is free from discomfort.

chair, or in an automobile during a long ride often causes backache.

The etiology in any given case will govern the treatment. This may be either conservative or operative.

All acutely painful backs with or without radiating pain should be put at rest on a rigid bed, and some form of physical therapy, such as heat and massage begun. Large doses of salicylates are of benefit. Head and pelvic traction or a plaster cast may be necessary to relieve the muscle spasm in a certain number of cases. Many patients experience great relief from a well applied adhesive plaster strapping. If this

does afford the desired relief, a rigid lumbosacral corset may well be prescribed instead of the adhesive plaster which irritates the skin of many patients. In many cases of painful sacro iliac joint an ordinary belt such as men wear buckled tightly around the pelvis just over the trochanters, gives prompt relief. All foci of infection should be carefully sought for, and eliminated. This is especially true in the intestinal tract, teeth and tonsils, however, teeth should not be extracted just because they are devitalized, but all abscessed teeth should be removed.



Fig. 23.—Sacralized fifth lumbar transverse process. Anteroposterior view of lumbar spine showing tibial grafts in place.

In some cases where the disability comes on suddenly following an injury, manipulation under anesthesia followed by rest on a rigid bed for a few days is sufficient. Other more severe cases require immobilization in a cast or brace. In many instances the patient is not relieved by conservative measures and surgery becomes necessary. These are the chronic cases in which there is definite clinical and x-ray evidence of disease or deformity. In a certain number of cases affection of the lumbosacral or sacro iliacs cannot be differentiated. In such cases all three joints should be ankylosed. For the lumbosacral arthrodesis the Hibbs' technic has

been quite generally used, with the addition of two large tibial grafts. These grafts are cut from the flat surface of the tibia



Fig. 24.—Scoliotic scoliosis. Recovery following spinal fusion

and are as wide as the bone will allow without destroying the crest. One end of each graft is cut on a slant so that it fits

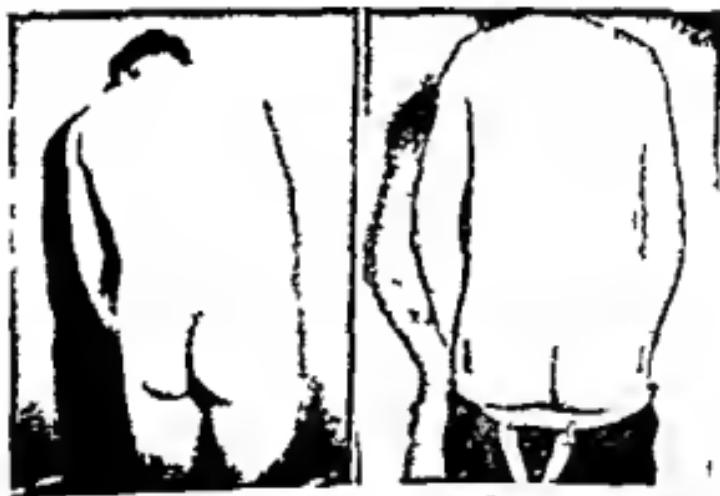


Fig. 25

Fig. 26

Fig. 25.—Photograph showing angulation of back before operation

Fig. 26.—Same as Fig. 25 after trisacral fusion. No further complaints

well in the sacrum and down in the lumbosacral angle. The grafts are fitted in edgewise, one on either side of the denuded

spinous processes, with the medullary surface in contact with the spinous processes. We have had failures where we have used the Hibbs' method, or the single tibial graft alone, and also where we have used the crest of the ilium for a graft. In all our cases, so far, where we have added the two wide tibial grafts a heavy mass of bone has been formed, and no failure of ankylosis has occurred (Fig 24).

The Smith Petersen operation is an extremely good one if one or both sacroiliacs are to be arthrodesed but for the trisacral arthrodesis the extra articular operation on the

- " " done (Figs 25, 26)
the disability is a real

The operation has the patient to bed for eight weeks. A special form of back support

must be worn until four months have elapsed. After four months the patient may gradually resume normal activity.



CLINIC OF DRs SAM W BANKS AND EDWARD L COMPERE

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LESIONS OF THE INTERVERTEBRAL DISK AS RELATED TO BACKACHE AND SCIATIC PAIN

THE physician is constantly confronted by patients who present the problem of chronic low back pain, with or without "sciatica" which may be intermittent or chronic, and is often intractable. In this clinic we shall discuss the rôle played by lesions of the intervertebral disk in the etiology of this syndrome.

"Sciatica" is a symptom. The term denotes pain in the area of distribution of the sciatic nerve. Primary sciatic neuritis, as in syphilis, diabetes, alcoholism, or lead poisoning may occur but is comparatively rare. More commonly low back pain and "sciatica" are caused by a tumor of the cauda equina, benign or malignant tumors of the lumbar spine and pelvis, congenital anomalies, spondylolisthesis, osteoarthritis of the lumbosacral and sacroiliac joints, tuberculosis, neurotrophic changes, fractures, or *lesions of the intervertebral disk*.

Within the past ten years the importance of lesions of the intervertebral disks between L5-S1 and L4-L5 vertebral bodies has become recognized as the most common single primary factor in the etiology of low back pain and sciatica.

Anatomy of the Intervertebral Disk—Knowledge of the structural anatomy and physiology of the intervertebral disk is necessary for the recognition and interpretation of pathological changes in it. The human spine contains 23 disks. One is found at each intervertebral level above the sacrum. Each fibrocartilaginous disk is composed of three parts—the annulus fibrosus, the nucleus pulposus, and the

cartilaginous plate covering the central portion of the contiguous surface of the vertebral body on each side of the disk. The circumferential annulus fibrosus constitutes a restraining wall and is attached to the raised rim of bone about the edge of the superior and the inferior surfaces of the vertebral bodies. The fibroelastinoid nucleus pulposus forms the center of the disk and is separated from the bodies by the two cartilaginous plates. The anterior portion of the annulus is reinforced by the strong anterior longitudinal ligament. The posterior longitudinal ligament is considerably reduced in size in the dorsal and lumbar areas and is here limited to the midportions of the backs of the disks. *The posterolateral portions of the disk which border on the spinal canal are not reinforced by accessory ligaments or muscles.*

There is no known nerve supply to the intervertebral disk but stresses and strains transmitted through it to the adjacent structures can produce pain referable to the disk area.

Function of the Intervertebral Disk.—The resilient fibrocartilaginous structure of the intervertebral disk allows it to modify and absorb shocks or strains transmitted along the vertebral column. It also performs a function similar to a ball bearing upon which the bodies move in flexion and extension of the spine. The shape and position of the incompressible nuclear material is dependent upon the integrity of the annulus fibrosus and the cartilaginous plates. Expansion of the disk during trauma occurs at the expense of the annulus and its supporting tissues. As a result of repeated trauma of everyday use of the spine or after a severe injury the annulus fibrosus may become weakened and the disk may bulge or the nucleus herniate into the surrounding structures. This most frequently occurs to either side of the posterior longitudinal ligament where the disk wall is the weakest. When the disk bulges or herniates backward into the spinal canal it may impinge upon the spinal cord or nerve roots. A bulging disk or a small herniation may be just sufficient to irritate a single nerve root. Larger protrusions may compress the cord even to the point of complete physiologic transsection. In rare instances the herniated nucleus may sever all connections with the disk and migrate up or down the canal between the dura and the spine or around the cord to its posterior surface.

Until recent years these lesions were called extradural chondromas and their etiology was not known.

Clinical Picture and Findings—The typical clinical picture presented by a patient with a retropulsed intervertebral disk is that of recurrent attacks of pain in the low back and sciatica which may be intermittent or intractable, unilateral or bilateral. The onset may follow a trivial injury, or it may be gradual without a history of definite trauma. The greatest number of herniations of the disk are encountered in the lumbosacral area with impingement upon the fourth or fifth lumbar or the first sacral nerve roots. The referred pain may radiate down the back of the thigh or to the lateral side of the calf and the region of the lateral malleolus. Coughing, sneezing and straining will aggravate the distress if the herniated disk obstructs the free flow of cerebrospinal fluid.

A detailed neurological survey should be made of all patients with sciatica. A diminished or absent Achilles tendon reflex with vague sensory alterations are the most constant and suggestive neurological findings.

Roentgenograms of the lumbosacral spine will show a decrease in the intervertebral space in approximately one third of the cases but the roentgenographic findings are not diagnostic for this condition. Good roentgenograms do help to exclude other conditions which may produce backache and sciatic pain.

Lumbar Puncture—When the history and physical findings are suggestive of a herniation of the intervertebral disk a routine spinal puncture is indicated. The Queckenstedt test may indicate the presence or absence of a partial or complete block of the subarachnoid space. The total protein value has been found elevated in a majority of the proved cases of ruptured intervertebral disk reported in the literature. If the value is elevated above 40 mg per 100 cc., we may suspect the presence of a nerve root lesion. Lipiodol may be used to confirm the diagnosis and to locate the exact site of the lesion in a patient when there is some evidence that the disability may be caused by an intraspinal lesion.

Lipiodol Examination—Two to 5 cc. of lipiodol are injected into the lumbar subarachnoid space after the removal

of a similar amount of cerebrospinal fluid. The patient is then placed face downward on a tilting fluoroscopic table. This will enable the oil to be in intimate contact with the posterior surfaces of the vertebral bodies and with the intervertebral disks. The table is tilted and the column of radiopaque oil observed as it is allowed to pass up and down the subarachnoid space. A persistent defect observed in the opaque shadow at the level of an intervertebral space by fluoroscopic examination, and verified by roentgenograms justifies a diagnosis of herniation of an intervertebral disk or a spinal cord tumor. A further differential diagnosis is not immediately essential, for laminectomy is indicated in either instance.

Treatment.—Laminectomy is indicated in the treatment of retropulsion of the intervertebral disk into the spinal canal, but every patient who presents a defect in the lipiodol shadow should not be subjected immediately to surgery. A bulging disk cannot always be differentiated from a definite rupture and herniation of the nucleus. A trial period of conservative orthopedic care may be indicated.

When the position of the retropulsed disk can be accurately determined, two or, at the most three laminae should be removed. In unilateral protrusions, hemilaminectomy may afford adequate exposure. More extensive removal of the laminae weakens the spine and if the patient must earn his living by manual labor, arthrodesis of the spine at the site of operation is indicated. The disk may be approached transdurally, or the cord and its coverings may be retracted to one side. Whenever possible, the lipiodol should be removed. Convalescence may be complicated by mild bladder disturbances which should subside in from three to six days. The patient may be ambulatory in three weeks and may resume his usual activities in from four to six weeks. He should not be permitted to do heavy lifting for at least three months following the operation. We have selected the following cases as typical of those presenting the syndrome of backache and sciatic pain caused by herniations of the intervertebral disk into the spinal canal.

area for over four years, she had attributed to "female trouble." The onset of pain in the leg was numbness in the right fifth toe, and later the third and fourth toes the bottom of the foot and finally the back of the leg. Within a few days she began to have severe pain which originated in the lumbosacral area radiated down the right leg to the ankle and was accentuated by activity.

Physical examination revealed no list or scoliosis but there was tenderness upon palpation over the lumbar spine. The right ankle reflex was absent. Touch pressure and temperature sensations were diminished over the right sciatic distribution. Pain was produced by right straight leg raising. Roentgenograms of the lumbar spine and pelvis were normal. The spinal fluid was clear and showed a normal pressure response. A fluoroscopic examination following the injection of 2 cc of lipiodol disclosed a defect in the column of iodized oil on the right side of the spine at the level of the disk between ver-



Fig. 27.—Roentgenogram of Case I after lipiodol injection. Shows typical punched-out defect in radiopaque shadow produced by retropulsion of a portion of the fifth lumbar disk.

tebral bodies L5 and S1 (Fig. 27). A diagnosis of prolapse of the L5-S1 intervertebral disk was made and verified when a laminectomy was performed.

A mass of fibrocartilage lying anterior to the dura attached to the intervertebral disk to the right of the midline compressing the first sacral nerve root and the adjacent cauda equina was removed. The ligamentum flavum opposite the disk at the level of the fifth lumbar vertebra appeared to be thickened. The patient obtained immediate relief and has remained well and free of the sciatic pain.

Comment.—Low back pain without a history of trauma had been present for nearly four years before the onset of numbness and sciatica. The roentgenograms of the lumbosacral

sacral spine were normal and the spinal fluid showed no changes. The neurological findings pointed to a lesion of the cauda equina at the lumbosacral level. The lipiodol examination, in spite of other negative laboratory tests made possible the correct diagnosis.

Case II.—A housewife fifty-four years of age four years before coming to the University of Chicago Clinics fell down 10 steps striking the lumbosacral spine. After three days in bed the local pain and tenderness disappeared. One year later she began to have pain in the lumbosacral region with radiation down the sides of both thighs to the knees more severe on the left. This pain was most marked while lying on her back. She had difficulty getting out of bed in the morning because her back felt stiff. After mild activity this early morning lameness became less pronounced. A diagnosis of arthritis and neuritis was made and following sedation, rest and the wearing of a surgical corset she was relieved of her symptoms. One year later the pain in the left leg returned and the ankle became swollen and discolored. The swelling subsided but the left sciatic pain persisted and had been present for two years when she consulted us although treatment had included rest, heat, massage, chiropractic manipulations and a back support.

Physical examination showed there was tenderness to deep palpation of the lumbar spine with limitation of pain motion in all directions. The left calf muscles were atrophic and weak and the left ankle jerk could not be elicited. There was complete anesthesia to pin prick and cotton wool over the distribution of the first to fifth sacral segments on the left and hyperesthesia over sacral three to five on the right. Position sense was lost in the left fourth and fifth toes.

The roentgen examinations of the lumbosacral spine and pelvis were reported as showing no abnormalities. A lumbar puncture revealed normal dynamics, the Pandy test was slightly positive and the total protein value was 26 mg per cent. No defect or block in the opaque shadow could be demonstrated on lipiodol examination.

right side. In the posterior to the dura and adjacent to the intervertebral disk between the fifth lumbar and the first sacral vertebrae. The patient made an uneventful recovery and has remained free of backache or sciatic pain.

Comment—Intractable sciatica which this patient suffered for two years was not relieved by the usual conservative measures. An exploratory laminectomy was made because of

the positive neurological findings, although all laboratory tests were negative. The tentative diagnosis of a ruptured intervertebral disk was confirmed and the patient was cured.

Case III—The third patient is a railroad switchman thirty three years of age who was first seen in the urology clinic of the University of Chicago because recurring attacks of frequency nocturia dysuria and urgency of eight



Fig. 23.—Roentgenogram of Case III demonstrates obstruction to lipiodol at fourth lumbar vertebra.

years duration had grown progressively worse in the preceding several weeks. A diagnosis of chronic cystitis was made and bladder irrigations gave marked relief with healing of an ulcer. Three months later the patient slipped on an icy street while returning home from the clinic. He was able to catch himself and did not fall. He complained of pain immediately following this accident in the lumbosacral spine and down the anterior and posterior surfaces of both legs. A tingling sensation and then numbness was felt in the same areas. The patient walked several blocks back and was admitted to the hospital because of the severe pain. Upon questioning he gave for the first time a history of

recurrent attacks of pain in the low back during the past six years. This had become more persistent and severe during the past six weeks and he had been unable to do heavy lifting and had curtailed his activities. When he was examined, the bladder was palpated above the symphysis, and he was not able to void. Straight leg raising produced pain in the left sciatic nerve distribution. The reflexes were present and equal on the two sides. An area of anesthesia to pin prick and cotton wool was found over both gluteal areas and hypalgesia to pin prick down the posterior aspects of both lower extremities.

An indwelling catheter was used for nine days after which the patient voided spontaneously. Roentgenograms of the lumbosacral spine showed



Fig. 29.—Anteroposterior view of Case III.

bral disk, was followed. The patient was discharged from the hospital three weeks after surgery completely free of pain.

Comment—Acute sciatic pain and paralysis of the bladder were noted immediately after minimal trauma. The positive clinical findings included elevation of the total protein of the spinal fluid and a complete block of the Ipiodol. After rest in bed, with an indwelling catheter in place, there was marked improvement. This is significant since a defect in the Ipiodol shadow has been observed to disappear after bed rest or the application of a body cast, and the two observations support the theory that some of the prolapsed disks may be restored by conservative management only. Laminectomy in this case revealed the extruded disk. Removal of this disk was followed by complete recovery of the patient.

Case IV—Three or four years ago this forty seven year old male patient had an attack of severe pain in the lumbar spine. He recalled no injury which might have contributed to this disability. A canvas belt with a sacral pad was secured and the pain was relieved after about seven days. There were recurrent attacks at intervals of about two months during the next three years. With each episode of pain he wore the canvas belt and obtained relief after a few days. Six months ago he suffered an acute attack of pain down the backs of both lower extremities. Two days later while lifting a piece of heavy iron he felt something give away in his back. He fell to the ground was not able to arise and was carried to his home. For several weeks he remained helpless in bed for with each attempt to move his legs the sciatic pain was increased. At length the distress diminished so that he was able to be up but he was still incapacitated six months after the acute onset of sciatic pain when he was first seen in this clinic.

Physical examination revealed a slow hesitating stiff legged gait. Tenderness to pressure was present over the fourth lumbar vertebra but none over the sciatic nerves. There were myoclonic twitchings over the posterior aspect of the right thigh. The Kernig sign was positive on the right. The flexors of the right knee were definitely weak and the patella and Achilles tendon reflexes were hyperactive. Sensory examination revealed hyperesthesia to painful and tactile stimuli over the posterior aspects of both lower extremities. No cerebrospinal fluid could be obtained between lumbar three and lumbar four vertebrae but a spinal puncture was successful at the L4 L5 level. The Queckenstedt test showed a partial block and the total protein value was elevated to 198.5 mg per cent. Fluoroscopic examination after injecting radio opaque oil disclosed a complete block at L4.

Laminae I³ to L5 were removed. As the dura was opened the nerve roots of the cauda equina appeared to be injected and pushed backward at I³. There were no roots at L5. The nerve roots were found to be normal. A large extruded disk was found at L4. The posterior longitudinal ligament which bulged into the spinal canal from the

disk was removed. The patient was unable to void until the third postoperative day but subsequent recovery has been complete.

Comment—This man presents a classical history and findings of herniation of the intervertebral disk into the spinal canal. Intermittent attacks of backache preceded the onset of intractable sciatica. He obtained relief immediately fol-

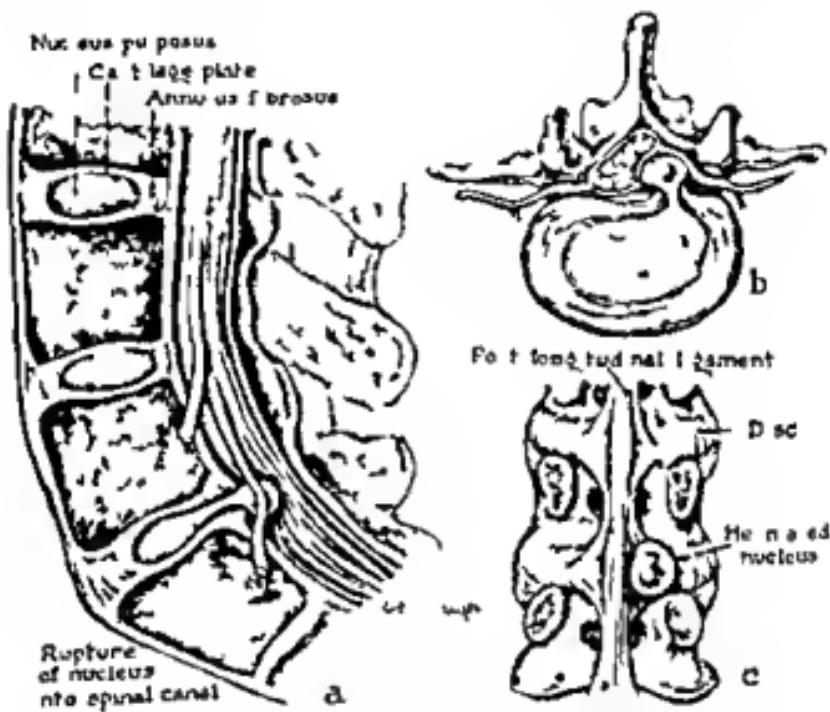


Fig. 30.—*a* Mid-sagittal diagrammatic sketch shows retropulsed lumbo-sacral disk with compression of cauda equina and first sacral nerve root. *b* Transverse view of same lesion. *c* Laminae and pedicles removed to demonstrate relation of herniated disk to posterior longitudinal ligament.

lowing surgical removal of the displaced fibrocartilaginous disk and has resumed his occupation as a junk dealer.

Discussion—Herniation of the intervertebral disk backward into the spinal canal with nerve root irritation or compression of the cord must be accepted as a definite clinical entity. The report of 38 cases from the Massachusetts General Hospital and 100 cases from the Mayo Clinic would indicate that the syndrome is less uncommon than the relative

infrequency of its diagnosis in most of the clinics would seem to indicate. Fincher and Walker have reported their experience with 31 consecutive cases of sciatica in which lipiodol studies were made. Retropulsion of an intervertebral disk was demonstrated in 24 of the 31 cases and after the removal of the extruded material, all were relieved of pain.

The Discogenetic Syndrome—Although only 11 patients with herniation of the intervertebral disks into the spinal canal have been subjected to a laminectomy operation, nearly 3000 patients have been treated because of low back pain with or without recurrent attacks of sciatica. Most of these patients were benefited, if not completely cured, by nonoperative methods of treatment. While we have been convinced that the most common etiologic factors in producing the syndrome are mechanical changes in the intervertebral disk between the fourth and fifth lumbar and the fifth lumbar and the sacrum not all and probably only a small per cent of these lesions included herniation of the disk into the spinal canal.

The mechanism of the production of pain in the discogenetic syndrome includes narrowing of the intervertebral disk space between lumbar 4 and 5 or lumbar 5 and the sacrum. This may result from an acute injury with rupture of some of the fibers of the annulus fibrosus with bulging of the disk or a complete tear and escape of the nuclear material into the surrounding tissues. The disk may also gradually wear thin from traumata of daily activity, dehydration, degeneration and fibrous replacement. Chronic lordosis from malposture shifts the weight bearing stress to the posterior portion of the disk. This may cause compression of the disk material with narrowing of the intervertebral joint space posteriorly and cause the disk to bulge laterally or into the spinal canal. The disk can no longer function efficiently under these circumstances and the strain of weight bearing is shifted posteriorly to the small and inadequate articular facets. A further increase in the lordosis develops and partial luxation of L4 on L5 or L5 on S1 may follow. The fifth lumbar vertebra may become posteriorly displaced on the sacrum creating what has been termed "posterior spondylolisthesis." As the facets subluxate and the fifth lumbar vertebra "settles" on the sacrum, the acuteness of the lumbosacral angle increases and the neural

foramina through which L5 nerve roots pass become smaller in diameter. The nerve roots may be mechanically irritated or compressed resulting in low back pain and sooner or later sciatic neuritis.

Extensive loss of disk substance and decrease in the inter vertebral space will result in increased stress and mechanical irritation between the contacted surfaces of L5 and S1. This may cause marginal lipping or osteophyte formation especially on the contacted anterior vertebral margins.

History—A history of injury may not be elicited. Onset may be acute or slow and insidious. The pain is more marked when the patient is tired and is accentuated by the strain of lifting regaining the erect position after bending over or any activity in which there is active extension of the lumbar spine. Positions that reduce the lordosis serve to make the patient more comfortable. Sitting slumped down with weight on the sacrum a bolster under the knees when lying on the back or lying on the side with the thighs flexed all help to bring about temporary relief from the pain.

Physical Examination—The typical patient presents on physical examination a hollow back (lumbar lordosis) prominent abdomen and an increase in the pelvic obliquity secondary to the acute lumbosacral angle and rotation of the pelvis. The gluteus maximus and abdominal muscles are commonly soft and 'flabby', the iliotibial band is tight and contracted and the hamstring muscles may be shortened. There is tenderness upon deep pressure over the articular facets L4 to S1. Bending in all directions may be limited by muscle spasm. Backward bending may cause localized lumbosacral pain with radiation down the sciatic nerve. Straight leg raising is resisted by the tight hamstring muscles and the short iliotibial band prevents complete thigh extension. Continued nerve root irritation or compression may produce changes in sensation and diminution or loss of reflexes.

A lateral roentgenogram of the lumbosacral spine should always be available. It may demonstrate a narrow intervertebral disk space with an increase in the lumbosacral angle. Sclerosis of the contiguous surfaces of vertebral bodies and osteophyte formation may be observed. Subluxation of the articular facets and a decrease in the diameters of the foramina through which the fourth or fifth lumbar nerve roots exit are

significant and almost constant findings in the discogenetic syndrome

Spinal puncture may reveal no deviation from the normal. Conservative orthopedic care consists of an extra rest period daily, high vitamin diet, physical therapy (infra red ray or inductotherm followed by massage to the back), exercises especially planned to strengthen the gluteus maximus and abdominal muscles and to stretch the tight hamstrings and iliotibial band, and a special back brace which should be worn for six months to one year.

If the patient is not helped by the above program, he should be manipulated under a general anesthetic. In this procedure we attempt to obtain by forced manipulation what the active corrective exercises have failed to accomplish. These maneuvers consist of forced straight leg raising to stretch the hamstrings, hyperextension of the hips with the pelvis fixed to stretch hip flexors and the iliotibial bands, and flexion of both hips with knees extended to correct the lumbar lordosis. A plaster cast including the body and legs is advisable for three weeks following the manipulation in severe cases with neurotrophic changes. Rest on a firm bed for from two to three weeks after manipulation may be adequate protection for the milder case.

If a conservative program does not bring about recovery, arthrodesis of L4 and L5 to the sacrum with excision of the articular facets if sciatic neuritis is present, has proved to be the procedure of choice. A portion of the intervertebral disk should not be excised unless it is definitely displaced into the spinal canal.

We are presenting the case reports of 2 patients whose disability resulted from a discogenetic lesion.

Case V—II R. female thirty nine years of age a graduate nurse entered the University of Chicago Clinics July 21 1937. On the preceding day she had slipped on the rocks of the breakwater while swimming in Lake Michigan. She was completely disabled with pain in the back and the left leg. She was treated by traction on the leg and subsequently by a cast and remained in the hospital for six weeks. At no time was she free from pain although the severity gradually became less marked. Pain in the back and occasional pain in the left leg persisted during the succeeding months and became acute when she attempted to lift any heavy object. Backward bending also caused an exacerbation of the sciatica.

About ten months after her original entry she slipped and fell on a waxed

floor and was again totally disabled with pain in the low back and down the left leg. She then consulted us in the Orthopedic Clinic. An x ray (Fig. 31) revealed narrowing of the disk space L5-S1 and the clinical findings were typical of the discogenetic lesion. Manipulation was performed under a general anesthetic and she was given physical therapy and a hollow back brace.



Fig. 31.—Lateral roentgenogram of Case 1 showing marked decrease in the intervertebral space and neural foramen between L5 and S1.

Three weeks after this manipulation she was found to be completely relieved of her previous disability and was permitted to resume normal activity.

Case VI—J. F. W., a male physician aged fifty seven years consulted us in July 1938 because of pain in the lumbar region of the back and along the course of the sciatic nerve. There was no history of a back strain or injury. The onset of this pain was first noted when the patient was about eighteen or nineteen years of age and persisted with some increase in severity, during the years in which he attended medical school. At that time he consulted certain of his professors but obtained no relief from the measures recommended. This pain has persisted throughout all of the intervening years without any definite change. The patient describes the pain as quite similar to that experienced in toothache. It is most marked in the backs of the thighs and the outer side of the leg below the knee and has been present constantly when standing or sitting. After lying down this pain entirely dis-

appears and he is able to sleep without any sedative or narcotic. In spite of this disability the patient has led an active life as a general practitioner in a small town and rural district. Physical examination revealed a very flat lumbar spine without the usual anterior curvature. There was definite muscular resistance which prevented a normal range of forward or lateral bending and backward bending caused an increase in the sciatic pain. Moderate tenderness to deep palpation was elicited on either side at the lumbosacral level. A search for a possible focal infection did not reveal any pathology in nose, mouth or throat.



Fig 32.—Lateral roentgenogram of Case VI. Shows complete loss of fifth lumbar disk space with posterior subluxation (posterior spondylolisthesis) of LS on the sacrum.

A roentgenogram was made of the lumbosacral region. This revealed complete absence of the intervertebral disk space between the fifth lumbar vertebra and the first sacral vertebra (Fig 32). The articular facets between the fifth lumbar and the first sacral vertebrae were luxated and because of the posterior downward slope of the articular facet of the first sacral the fifth lumbar vertebra has been dragged backward creating a very marked posterior spondylolisthesis. An operation for excision of the articular facets between the fifth lumbar vertebra and the sacrum and arthrodesis of the fifth lumbar vertebra to the sacrum was advised.

Comment—Roentgenographically and clinically this was a very excellent example of the end stage of the fifth lumbar discogenetic syndrome. It would be almost inconceivable that the fifth lumbar nerve roots could emerge from the narrowed foramina without some impingement on the nerve roots from the pedicles, osteophytes or from edematous soft tissues lining the canal. It is also probable that a portion of the disk L5-S1 may have been extruded into the spinal canal contributing to the disability.

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TREATMENT OF HABITUAL DISLOCATION OF THE SHOULDER

IN the shoulder joint the glenoid cavity is a relatively flat surface—slightly concave because of the glenoid ligament. Only a small portion of the spherical head of the humerus approximates the glenoid cavity as the arm moves in various directions.

Theories held by various surgeons regarding predisposition to dislocation of the shoulder are:

1 Any alteration of the shape of the articulating surfaces such as congenital or acquired defects of the head of the humerus or of the glenoid as a result of fracture or erosion of its edge tend to diminish the security of the joint.

2 Fractures of the greater or lesser tuberosities of the humerus either with or without rupture of the attached muscles.

3 Weakness of the capsule from detachment at the anterior inferior margin of the glenoid or relaxation following lacerations which have not been repaired or by repeated stretching without complete rupture. The normal capsule has relatively little strength as compared to the severe strains which are placed upon it and besides it is too relaxed to hold the head of the humerus approximated to the glenoid.

4 Impairment of the normal function of the muscles of the shoulder girdle. These muscles especially the subscapularis supraspinatus infraspinatus and teres minor hold the arm to the scapula. All of the arm motions depend on the fixation of the scapula mainly by its muscular attachments as the only skeletal fixation is through the clavicle to the sternum.

Dislocation of the head of the humerus upward is prevented by the acromial process and the coraco acromial ligament. Anterior dislocation is resisted by the powerful tendon of the subscapularis, by the tendon of the long head of the biceps and the glenohumeral ligament while posterior dislocation is rare because of the coracohumeral ligament, the external rotators and the manner in which strain is applied to the shoulder.

In abduction of the arm, while in pronation, the greater tuberosity strikes on the acromion at about 90 degrees and further abduction is accomplished by motion of the scapula. However, if the arm is externally rotated in abduction so that the notch between the tuberosities is even with the acromial process, further abduction is possible as the greater tuberosity rotates externally under the acromial process. However, since most falls naturally occur on the pronated hand with internal rotation the greater tuberosity strikes on the acromial process and if the force is continued and if there are no fractures the head of the humerus is forced downward onto the weak inferior portion of the capsule which becomes tense or ruptures with the resulting dislocation.

Subsequent dislocations may result from major traumata or from trivial strains such as reaching up for a hat, or on swimming.

MECHANISM OF DISLOCATION

The dislocation always occurs when the arm is out

except in the cases of paralytic dislocation in which the shoulder is flail from paralysis of the muscles of the entire shoulder girdle.

In considering the stress or force which produces the dislocation, let us remember that we have the head of the humerus pressing on the capsule with as many times greater force as the length of the arm from the hand to the insertion of the subscapularis and external rotators as compared to the short arm of the lever, i.e., the distance from the insertion of the above muscles to the point of contact of the head of humerus to the capsule. Hence it is readily seen that the

capsule cannot withstand this force and it gives with the resulting dislocation

After reduction the laceration of the capsule is repaired more or less by scar tissue which does not have the strength of normal tissue to prevent future dislocations

Hence one dislocation often predisposes to another and when this accident follows several times as a result of minor strains we have the 'recurrent dislocation'

TREATMENT

Acute dislocation of the shoulder occurs so often that it is considered by the laity and the profession as a simple condition. However when it is estimated that 10 per cent of these acute dislocations may result in recurrent dislocations and since such a large variety of treatments have been advocated by the surgeons one then realizes that it is a complicated condition and should be considered more seriously.

The afflicted one not only loses the natural efficiency of the arm and has the repeated experience of pain and disability with the recurrent dislocations but also has the fear constantly of repetition of the accident.

Prophylaxis—It is natural to assume that if the originally reduced shoulder was maintained in adduction and if abduction was avoided for a greater length of time than is usual by both the patient and the surgeon that nature would repair the soft structures more securely and hence there should be a definite decrease in the percentage of this complication. However this is a difficult procedure especially since the arm feels so good to the patient after reduction and since there are so many strong energetic masseurs who wish to demonstrate their strength on the patient with the ill founded idea and lack of knowledge based on the superstition that the joint will become stiff unless it is moved in all directions early after reduction.

Conservative Treatment—Conservative treatment in the past has consisted of having the patient wear a restraining apparatus with a band around the body attached to another around the arm so fixed as to prevent abduction of the arm.

Arthur G. Davis has called attention to a conservative form of treatment which seems to have considerable merit and

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Subsequent dislocations may result from major traumata or from trivial strains such as reaching up for a hat, or on swimming.

MECHANISM OF DISLOCATION

The dislocation always occurs when the arm is outstretched, with abduction in which case the deltoid supra and infraspinatus are in a state of contraction. Without contraction of these muscles dislocation is not liable to occur except in the cases of paralytic dislocation in which the shoulder is flail from paralysis of the muscles of the entire shoulder girdle.

In considering the stress or force which produces the dislocation let us remember that we have the head of the humerus pressing on the capsule with as many times greater force as the length of the arm from the hand to the insertion of the subscapularis and external rotators as compared to the short arm of the lever, i.e., the distance from the insertion of the above muscles to the point of contact of the head of humerus to the capsule. Hence, it is readily seen that the

ball, basketball, and baseball—the adductors and internal rotators of the subluxating shoulder are definitely weaker than those of the left or normal shoulder.

It is our hope that by developing the musculature after this method we will be able to prevent further dislocations and subluxations in these respective cases.

Another conservative method for increasing the strength of the capsule has been proposed and may be accomplished by the injection of sodium psyllate. Schultz has found that the subluxations of the temporomandibular joint can be eliminated by this method. It causes a definite fibrosis of the capsule and adjacent ligaments and apparently causes no change in the articular cartilage.

The injected chemical frequently causes a rather severe reaction with considerable pain for a few days.

Operative Treatment—The cases of recurrent dislocation of the shoulder, which are not corrected by conservative measures may be cured in a large percentage of cases by open operative measures. However whenever many different forms of treatment are devised for some particular condition it is usually an admission that something is lacking for an ideal result. This seems to be the case with the various operative procedures, which have been proposed for the cases of "recurrent dislocation of the shoulder."

The surgical procedures fall into the following groups:

1 *Capsulorrhaphy*—Up until a few years ago most of the operative procedures consisted of some form of capsulorrhaphy. By reefing, imbrication and reinforcement of the capsule by fascia lata as advocated by Gallois by the crucial capsulorrhaphy through a posterior approach of Keller, and by the anterior approach of T. Turner Thomas, the axillary portion of the capsule is contracted and strengthened with a relatively large percentage of cures of this condition.

2 *Muscle Plastics*—Since the deltoid is always in a state of contraction in active abduction of the shoulder it is a source of danger and with the idea of having an automatic counter-balance sling the Clairmont Ehrlich operation was devised. It consists of separating the posterior one fourth of the deltoid muscle from its insertion—preserving the nerve and blood supply—and transferring this portion of the muscle under the

definite indications in females who do not wish to have operative scars on their shoulders or in those patients who are poor operative risks. His working hypothesis is based on the assumption that the stability of the shoulder joint depends on the muscle integrity. It consists of strapping the arm to the thorax so as to prevent abduction and backward motion to the coronal plane. There is some free range of motion in adduction and internal rotation. The patient is encouraged to use the arm within these limits and by apparatus for resistance exercises to develop their muscles for adduction and internal rotation *i.e.*, the pectorals, anterior portion of the deltoid, the subscapularis, teres minor, and latissimus. After two weeks when the adhesive is removed there is a definite increase in the strength of the exercised muscles and little tendency for the patient to abduct the arm. The specific exercises above are continued for another month.

It is believed that by fortifying the compensatory mechanism by overdevelopment of the internal rotators and adductors the anterior portion of the capsule is shortened and strengthened restoring the correct axial alignment of the head of the humerus to the glenoid. If the external rotators are stronger the arm is externally rotated. In this position the tendon of the long head of the biceps is more posterior and thus the anterior portion of the capsule or the anterior resistance has lost its assistance from the biceps tendon. With restoration of the strength of the internal rotators it is believed that the biceps tendon will press backward and externally on the head of the humerus thus serving as a check ligament and obstruction to dislocation.

Codman has called our attention to the alteration of the musculature of the human shoulder from that of the quadruped in that with evolution the human shoulder has been deprived of its anterior muscle guard. In the human attitude the arm is externally rotated about 45 degrees as compared to the relationship of the shoulder in the quadruped.

At this time we have 2 female patients following the treatment as outlined by Davis. One has the typical recurrent dislocation while the other subluxates her shoulder but does not completely dislocate it. Although the latter patient is naturally right handed and unusually athletic—playing foot

the arm is abducted with a weakness of the soft tissues and especially when the anterior inferior portion of the glenoid is diminished either by fracture at the time of the original dislocation, or worn off by repeated dislocations

It consists essentially of transplanting a graft of bone from the tibia into the neck of the scapula. It is placed at the anterior inferior margin of the glenoid projecting $\frac{3}{4}$ inch anteriorly and obliquely across the lower anterior margin of the shoulder joint. This procedure does not interfere with the range of motion at the shoulder joint. The projecting portion of the bone graft may atrophy and absorb from disuse but at the point of insertion of the graft into the scapula, as union takes place, callus is thrown out developing a definite mound of bone, which prevents the head of the humerus from slipping out of the glenoid anteriorly, as occurs in the recurrent dislocations.

4 Bone Operations—Hildebrand produced a more prominent anterior margin of the glenoid by deepening the posterior portion of the glenoid.

Excision of the head of the humerus prevents dislocation as does an arthrodesis of the shoulder joint. In doing these radical operative procedures one sacrifices any future chance for normal function of the shoulder but the end may justify the means in a certain few selected cases.

5 Suspension Operations—If the head of the humerus can be suspended and prevented from slipping downward dislocation can be avoided.

Carrell's method consists of producing a sling under the neck of the humerus. He divides the tendon to the long head of the biceps and attaches the lower end to the short head of the biceps. The upper end of the biceps tendon, which is elongated by a strip of fascia lata, is passed down through a posterior incision under the neck of humerus penetrating the capsule in and out emerging just above the teres minor where it is attached through a drill hole in the acromion.

Joseph suspended the head of humerus to the acromial process by fascia lata.

Henderson has advocated tenosuspension by using a portion or full thickness of the peroneus longus tendon. Parallel holes are drilled through the acromial process and through

humerus through the quadrilateral space with its reinsertion to the coracoid process. This procedure requires large incisions with considerable operative technic. Some failures of this procedure are probably from degeneration of the transplanted muscle or inability to securely anchor the transplant to the coracoid. The success of this procedure may depend on the cicatricial contraction of the axillary portion of the capsule as a result of the trauma which is necessarily the result of the free exposure, the passage of the deltoid muscle flap and the subsequent healing of the bared capsule.

Hyman transplanted the short head of the biceps from the coracoid process to the upper rim of the glenoid where it was securely attached to the bone and capsule, reinforcing the strength of the capsule.

Young and Sever have advocated weakening or lengthening the pectoralis major and the latissimus dorsi believing that the overactivity of these muscles was a factor in producing dislocation of the shoulder.

3 Check and Block Operations—Galhe and LeMesurier described a check to prevent abduction and thus avoid dislocation. They passed a strip of fascia lata through a hole in the neck of the scapula downward and fastened it through another opening in the undersurface of the humerus. The degree of tightness of this band is determined by the surgeon according to the amount of abduction desired.

Rich recommended the insertion of silk between the axillary border of the scapula and the humerus which would limit the motion at the shoulder.

Spitzky provided an artificial ligament by means of a loop of silk which was passed around the neck of the humerus and then secured it to the coracoid process with the silk enveloped in the capsule.

Oudard devised a bone block in front of the shoulder. This was accomplished by lowering the tip of the coracoid—using a bone graft to bridge the gap between the sectioned portions of the coracoid.

Eden also used a bone graft as a block placing it under the periosteum of the neck of the scapula.

Speed devised his operation for a definite mechanical block to prevent the head of the humerus from displacing when

complete anesthesia the shoulder could be subluxated but it was impossible to dislocate the shoulder. On exploration it was found that the proximal portion of the tendon was elongated. The operative repair consisted in transplanting the tendon again through a drill hole in the upper end of the humerus more medially. Since this procedure there has been no further subluxation or dislocation.

Hobart has advocated the combined operations of Nicola and Clairmont in those cases in which patients are subjected to severe trauma although he feels that the modified Nicola operation is adequate for most cases.

The choice of the form of treatment for recurrent dislocation of the shoulder should depend on the defective anatomy if it can be determined by the surgeon and his armamentarium.

If the etiology cannot be ascertained, conservative muscle development may be tried but if this should fail operative measures according to the choice of the surgeon will give a successful result in a very large percentage of the cases.

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the greater tuberosity of the humerus and then the tendon is looped through these openings for the sling. The success depends on securely suturing the ends of the tendon and on roughening the tendon surface so that it becomes securely attached to the raw bone surfaces through which it passes.

Fowler uses a strip of fascia for his sling operation. He passes it through the coracoid and through the capsule between the teres minor and infraspinatus under the neck of the humerus and then through the acromial process suturing the ends securely back onto the fascia.

Nicola has described a much simpler operation, which appears to result in a cure in most cases. He utilizes the tendon of the long head of the biceps. Originally he passed the divided tendon through a drill hole from the bicipital groove up to the middle of the head of the humerus and then re-sutured the ends of the divided tendon. This procedure has been modified in many ways.

Some surgeons have preferred to change the course of the transplanted tendon by placing the transplanted tendon through a drill hole which is located anterior to the bicipital groove emerging at the margin to the articular cartilage rather than in the center of the acetabulum. In this manner the tendon

subsequent pathological changes

In some clinics the Nicola operation has been further modified and simplified in that the tendon is not divided. Instead it is removed intact from the bicipital groove, which is deepened, and then the tendon is replaced in the newly prepared bone channel covered with bone chips and securely anchored. In fact, the success of the Nicola operation seems to depend on the integrity of the tendon and the firm fixation of the tendon to the bone through which it passes.

The opportunity for reoperation and examination of a failure of this type of operation was presented. The patient stated that he had had a recurrence of the dislocation after a severe injury to the previously operated shoulder. He was carrying a heavy log with a companion who suddenly dropped the other end, causing a sudden strain on the patient's shoulder with a resulting dislocation. However, on reoperation under a

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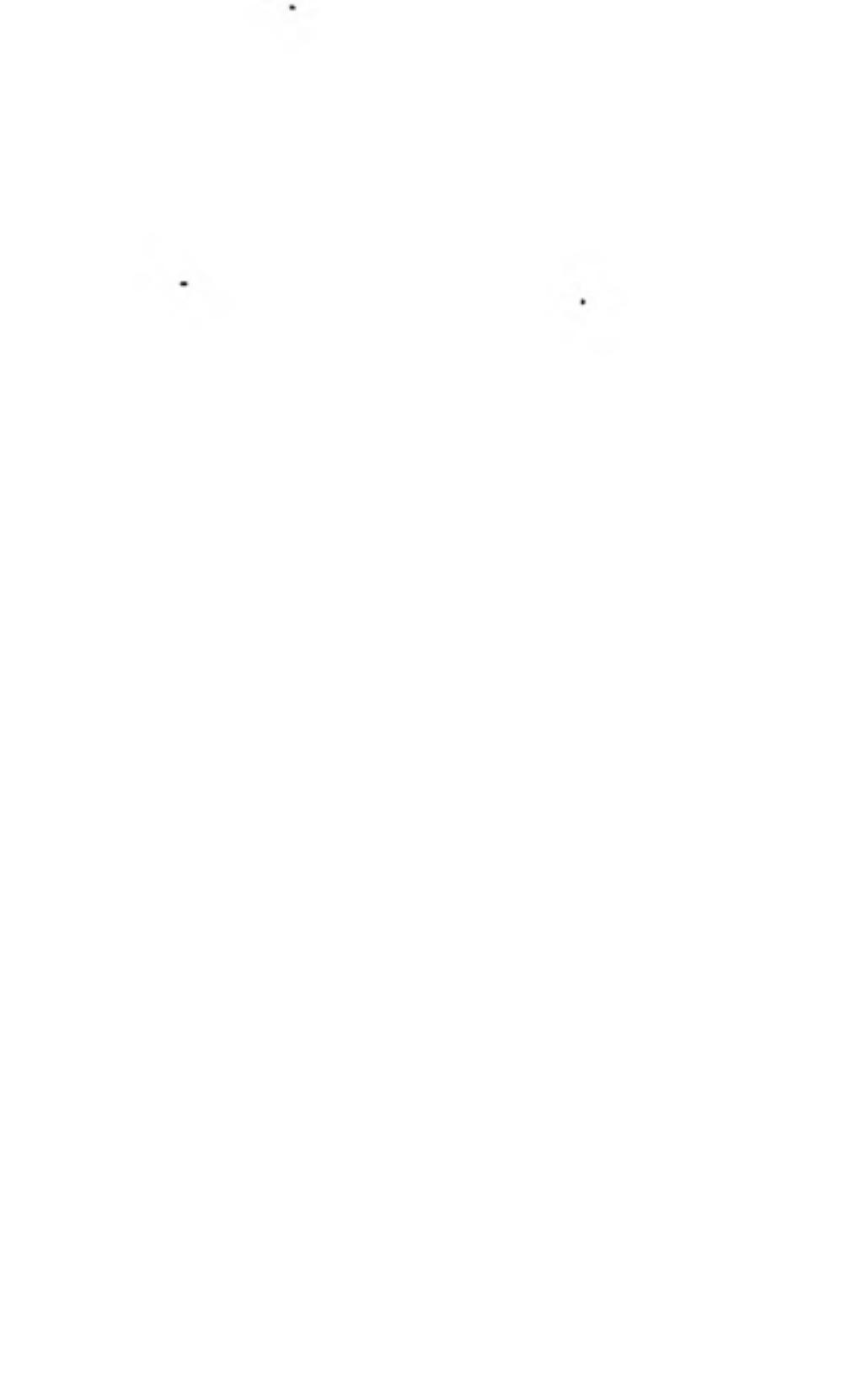
SHRINERS' HOSPITAL FOR CRIPPLED CHILDREN

LEG LENGTHENING

EQUALIZATION of the lengths of legs may be accomplished by four different methods (1) direct lengthening of the short leg, (2) shortening of the long leg, (3) retardation of growth of the long leg, and (4) stimulation of growth of the short leg. The first three methods listed are in popular usage. The last method, that of stimulating the growth of the short leg by activating the epiphysis, is still in the experimental stages and the results so far obtained are not consistently successful enough to advocate its adoption.

Shortening of the long leg was probably the original method attempted in equalization and if carried out skillfully and conservatively it yields excellent results. This method is quite popular and consists primarily of removing a section of bone and bringing the opposing ends together. Variations of means of holding the opposing ends together are many and due to the lack of tense muscle pull it is of importance that the ends be firmly joined. Nonunions and delayed unions which occur rather frequently by this method are often due to the lack of adequate fixation. Another consideration which occasionally assumes considerable importance in the mind of the patient is the fact that one is often loath to have the overall height of the body shortened 1, 2 or 3 inches. Finally, the question of permitting an extensive operation on the remaining good leg, which is usually the long leg, is vital. The danger of incurring disability in the remaining good leg and ending with two legs which are disabled causes many a prospective case to refuse surgical interference.

Retardation of the growth of the long leg is also open in the patient's mind, at least, to the two previously mentioned



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objections, namely, that of interfering with the overall height of the body and the possible danger of disabling the remaining good leg. Phemister and his coworkers have developed a fairly accurate method of determining the amount of retardation one can expect by so called "epiphyseal arrests" carried on at certain ages and the epiphyses damaged to more or less definite degrees. The operative procedure is not as simple as one might presume but if carried out carefully the results are usually satisfactory. The method, of course is only applicable in the growing child since when the epiphyses are closed retardation is impossible.

Leg lengthening has held an apparently irresistible appeal in the past ten years. The variety of formidable apparatuses which have been invented to aid in this type of procedure is legion and many of the complicated cumbersome types must give great comfort to the mechanical inventive mind of the originator but not to the patient. As is so often the case when a dramatic surgical method is introduced the rush to build up large series of cases and the temptation to try the method on practically any patient with a short leg has led to grievous errors and multiple complications. Success depends upon choosing the cases wisely and performing the operation in the simplest, most conservative manner possible.

Of existing surgeons Putti was among the first to attack the problem of leg lengthening successfully. His original method of oblique osteotomy with continuous traction, while lacking adequate control of the fragments did accomplish

and certainly the most persistent exponent of leg lengthenings

a wedge ^u ^u ^u
the good from the bad and the wise from the foolhardy ^u ^u ^u
Following Abbott's work at St. Louis Beveridge Moore ten

years ago in Chicago started using the same method on selected cases. After a few cases he, too, started changing the instrument and finally broke away from the conventional type and invented an apparatus which for simplicity, rigidity and ease of operation has few, if any, equals. The cases reported and illustrated here were done in conjunction with Moore and his type of apparatus was used. Minor refinements to permit improved x-ray visualization have been made but the basic cylinder plunger or so called "trombone" construction for extension remains.

Indications—Indications for leg lengthening are relatively few. The most common case for which this procedure is used is the residual anterior poliomyelitis victim in which one leg is considerably shorter than the other leg. Cases of congenital shortening of the lower leg, shortening following malunion of fractures, shortening following infection in the thigh or hip and rare cases of hypertrophy of the other leg resulting in excessive growth may in selected cases be materially benefited by leg lengthening.

Contraindications—The contraindications are many. No operations should be attempted under six or eight years of age. Preferably they should be older. In the poliomyelitis cases our series of 48 cases in the past ten years has led us to rather definite conclusions. (1) We insist that the other leg be a perfectly good member, (2) the shortening must exceed at least $1\frac{1}{2}$ inches to justify such an extensive operation, (3) the hip muscles must all have good strong function, (4) there must be good quadriceps femoris function, (5) the abdominal and spinal muscles must not be severely paralyzed, (6) the patient must be in good general health. If the above qualifications were more strictly adhered to by everyone many useless or harmful operations would be avoided. Cases of congenital shortening of the lower leg must have good muscle and joint function. Congenital shortening of the femur with good muscle and joint function has been successfully operated by femoral lengthenings by some men but our results have not been uniformly successful and we prefer to do lower leg lengthenings on these cases. Malunions of fractures of the femur or the tibia and fibula resulting in shortening should have reached the stage of fairly uniform bone diameter before

lengthening and here again we prefer to do only lower leg lengthenings. Again the muscle and joint functions should be relatively normal. Infections of the hip, such as tuberculosis or pyogenic types resulting in shortening of the leg, must be studied carefully before selection for lengthening. A stable hip, either by bony ankylosis or osteotomy, with the leg in good position must be present and the infection must have been long quiescent. Unreduced congenital dislocation of the hip comes in the same category—the hip must be stable, either by natural or artificial shelving or osteotomy. All cases other than the poliomyelitis ones present the additional difficulty of overcoming strong muscle action and solid unresisting bone. These factors add further obstacles to uniform lengthening.

Complications—The possible complications of the tibia and fibula lengthening operation may be listed as follows: (1) *infection*, (2) *malposition or fragments*, (3) *nerve injury*, (4) *foot deformity*, (5) *premature union of the fibula*, (6) *nonunion*, (7) *late fracture of the leg*. The possibility of infection is, of course, a relative matter. The extensive and rather prolonged exposure necessary to the operative work and the presence of multiple pins transfixing the bone make the hazard considerable. It is true, however, that the percentage of infections which have occurred in large series of cases has not exceeded that of other types of operations requiring a much smaller operative field and requiring a shorter time of exposure. Two minor infections which cleared up without incident occurred in our series at a charity hospital. One serious infection occurred in a private case.

Malposition of fragments is a common complication although with thorough dissection and loosening of the fragments and rigid fixation with multiple pins this does not happen as frequently as it previously did. When we first started doing leg lengthenings only one pin was used above and below the osteotomy. Angulation of the fragments was pronounced in several cases and two pins below and one pin above the osteotomy were tried. The angulation continued to occur and the use of two pins above and two below was instituted. This resulted in controlling the angulation satisfactorily provided that the Achilles tendon did not become too tight. This tendon is routinely lengthened at the time of operation.

except in poliomyelitis cases presenting a marked calcaneus deformity. With certain types of apparatus the angulation may be controlled somewhat by adjustable screws.

Nerve injury occurred in 2 of our early cases. The peroneal nerve became paralyzed in both cases but resumed its function after a considerable length of time. In 1 case lengthening progressed rapidly and it is presumed that the excessively fast stretching of the nerve did not permit the usual adjustment which takes place. In the second case the fragments were not separated smoothly enough and locked for a period preventing lengthening. Additional force was applied to the extension by means of a spring with the result that when the bones did slip apart a sudden stretch occurred which probably caused the temporary paralysis. With more gradual stretching these complications have disappeared.

Deformity of the foot may frequently happen, the usual type being an equinovarus type. The use of either elastic or rigid foot plates has not prevented this deformity since excessive pressure against the sole forces us to loosen the plate. This complication has never been serious and is usually corrected at the time the leg and foot are put in a plaster cast. The great majority of these cases are poliomyelitis victims and most commonly the short leg has associated foot deformity which requires stabilization of the subtalar joints. As the foot has a tendency to pull out of shape during the lengthening it is important that the subtalar arthrodesis be deferred if possible, until after the lengthening.

With the early cases the fibula tended to unite across the osteotomy before the total leg length had been obtained. We were distressed to find that the upper fibular epiphysis had separated from the shaft with a gap in 1 case of almost 2 inches. Our anxiety proved to be groundless, however, as the gap readily filled in with no bad results. In talking with other men doing similar operations I find that this complication is quite common but never has any undesired results. Since the early cases we have made a practice of removing a small section of the fibula rather than doing a simple osteotomy and have had no trouble with premature union of this bone.

Nonunion is the bugbear always brought up in discussions of leg lengthening. It is, of course, one of the worst compli-

cations which can occur but it seems to happen very infrequently. Of our entire series at the above mentioned charity hospital we have had no nonunions and only one union which was delayed and that only for a period of about three weeks longer than usual. The private case which became infected resulted in a nonunion and required a bone graft. Given sufficient overlap, surfaces which are not too smooth, good apposition and gradual lengthening union can be expected almost as often as with an ordinary osteotomy. Methods employed which do not offer the above qualifications may well result in an unusual number of nonunions. Careful choice of patients and careful technic should keep this complication at a minimum.

We have had several late fractures through the lengthened bones. These occurred after the patients had returned home and were running around without support. All of these have been in poliomyelitis cases in which the bone even before operation was below normal and sufficient time had not elapsed to permit the bones to harden properly. All healed without incident. Caution to putting excessive strains on the leg and some adequate support for a considerable period of time are advisable.

Operation.—With a selected case the operation as carried out by us is as detailed in the following description. The entire apparatus which with the exception of the pins, consists of only two main pieces is sterilized. After the usual pre-operative preparations the Achilles tendon is lengthened in all cases except the paralytic ones having marked calcaneovalgus deformities. This incision is then closed. A small incision is made next over the lower quarter of the fibula and a section from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length is removed being sure that the ends are entirely free. This incision is closed. A long incision is then made along the crest of the tibia and the periosteum stripped from top to bottom around the entire circumference of the bone. The Z shaped osteotomy is then marked out superficially on the bone, enough space being left above and

a small saw the bone is then cut down to the lowest hole, the cut being made through the anterior surface of the bone. A similar cut is then made up to the highest hole through the posterior surface of the bone. It has been found that if the



Fig. 33

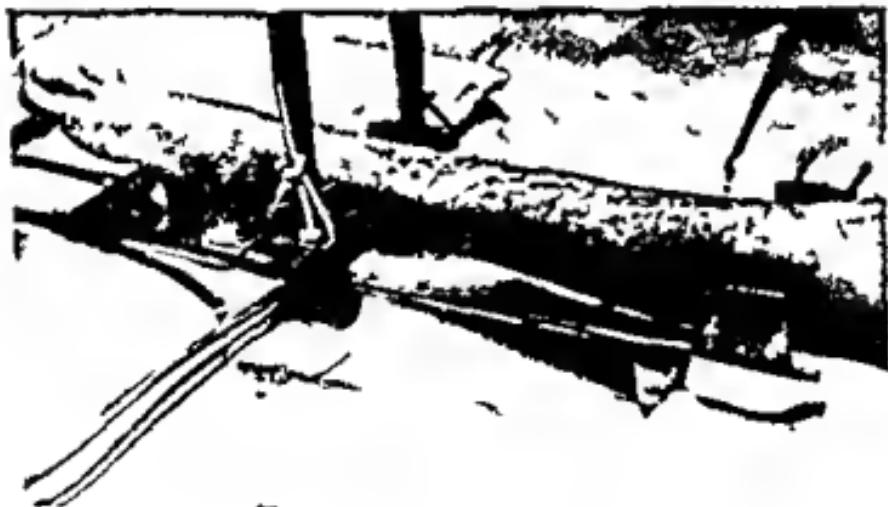


Fig. 34

Figs. 33 and 34—Views of apparatus in place

Z is marked in this direction there is not so much possibility of buckling of the fragments occurring as if the saw cuts are reversed.

Next the apparatus is placed in position and the pins are drilled through the skin, underlying tissues, bone and out the

opposite side of the leg. The holes in the apparatus act as guides for the proper alignment of the pins. A hand chuck is

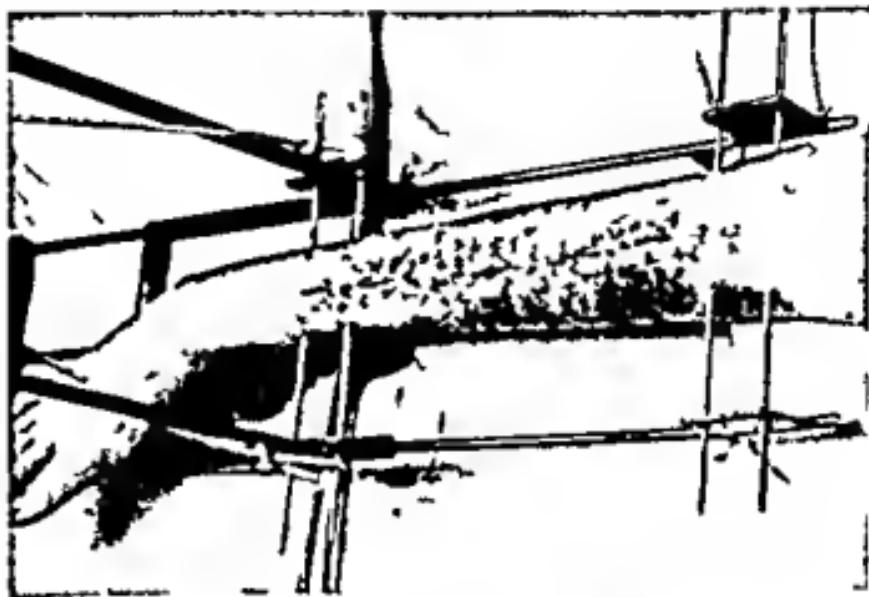


Fig. 35.—View of apparatus in place



Fig. 36.—Anteroposterior x-ray four weeks postoperative

used for drilling with the pins. These pins are made of so-called "18 8 inch" stainless steel and vary from $\frac{1}{8}$ inch

to $\frac{1}{4}$ inch in diameter depending upon the size of the bone. Two pins about 2 inches apart are used above and below the osteotomy, all the pins being parallel and rigidly fixed in the apparatus as soon as tension is applied. Next the drill holes are joined by using a small osteotome and cutting the bone between the holes. This completes the osteotomy and the steplike cutting is complete. After assuring that there is complete freedom of the ends the periosteum is closed and the skin sutured. A moderate amount of tension is applied to the stretching bar dressings are carefully applied where the pins

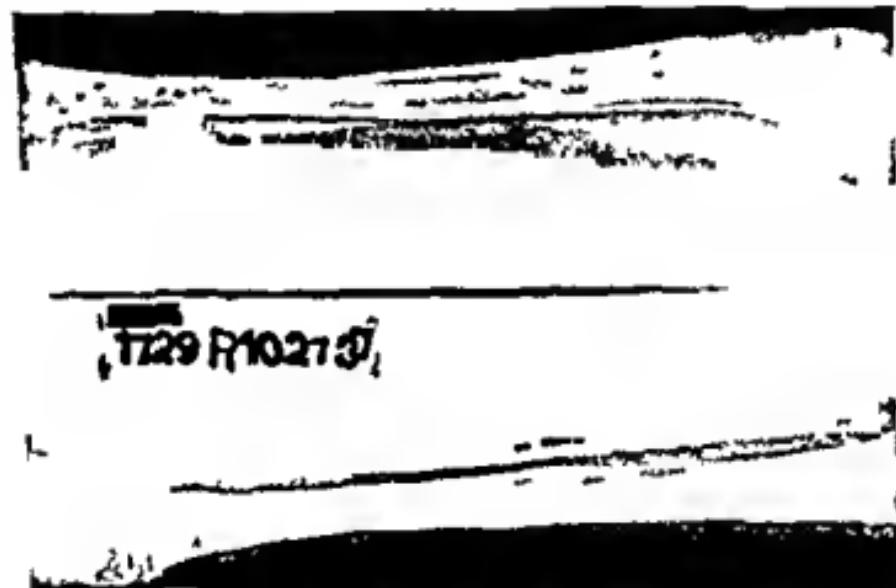


Fig. 37.—Lateral and anteroposterior x rays three months postoperative

emerge from the skin other dressings are applied as necessary and the patient is returned to bed.

The apparatus is swung with pulleys from an overhead bar permitting movement of the knee. The first two days very little additional tension is added but from the third day on lengthening progresses as the tension is increased. Ordinarily we figure on obtaining our total length in about three weeks so the amount obtained daily varies with the amount desired. It has never seemed wise to attempt to gain more than 3 inches of lengthening although we have on occasion obtained more than that without trouble ensuing. Dressings are usually not changed for about seven days and after that at very infre

quent intervals. Constant interference with the dressings is a principal cause of introducing infection. This seems to be true of all cases where pins are used for fixation.

α Rays are taken at weekly intervals with a measuring device placed at the same level with the bone. This gives a fairly accurate determination of the lengthening and checks the measurement on the apparatus. Often the pins bend somewhat and the accuracy of the α ray measurement is important. After sufficient length has been obtained the thumb screw is fixed in a stationary position and the case permitted to rest for about three weeks with the apparatus in place. Check by α ray at that time usually shows sufficient callus and solid bone formation to permit removal of the pins and the application of a plaster cast. A wheel chair is then allowed the patient and after four weeks gradual weight bearing is permitted. The cast is removed at the end of another four weeks and if the bone shows sufficient strength restricted activity gradually increasing in amount to the normal maximum is permitted.

The entire procedure is time consuming and formidable but with proper selection of cases and diligent attention at operation and postoperatively it seems to us to offer the best method of leg equalization. The complications which occurred in the early cases have been almost entirely eliminated in the last half of our series and we find an occasional minor complication the exception rather than the rule. We believe that the indications for operative equalization are few and the contraindications many but of the various methods advanced so far that of leg lengthening appears to offer certain advantages in solving the problem.

CLINIC OF DR. DANIEL H. LEVINTHAL

COOK COUNTY AND MICHAEL REESE HOSPITALS

TENDON TRANSPLANTATION IN THE LOWER EXTREMITY

TENDON transplantation consists briefly of a translocation of a tendon insertion combined with transplantation of the tendon to a new bed or channel.

Tendon transplantation in the lower extremity attempts to balance muscle power or overcome the power of gravity, the objective being to increase the power of propulsion, stability and equilibrium. By combining tendon transplantation or transference with stabilization (arthrodesis) operations recurrence of deformity is prevented. In some spastics tendon transplantation, tendon lengthening and partial neurectomy (Stoffel) may be necessary. In other words, stabilization alone in a foot having muscle imbalance is not sufficient to prevent recurrence of deformity in most patients.

The majority of cases requiring tendon transplantation are postpoliomyelitic paralysis, spastic paralysis, certain spinal cord lesions and old peripheral nerve lesions. The preliminary examination of each patient must be very carefully done and an accurate inventory of the muscle power noted. Each case presents individual mechanical problems, and, in the lower extremity, we must take into consideration the fact that muscle reeducation is more difficult than is the reeducation of the muscles of transplanted tendons of the upper extremity.

The plan of action is based on the mechanical problem and the inventory of the muscle power. In the lower extremity tendon transplantation is often combined with a stabilizing operation especially in the imbalanced foot following poliomyelitis or in the spastic clubfoot. *Deformity is always corrected before tendon transplantation.* Occasionally, a deformity is corrected preliminary to the tendon transplantation by manipulation and cast. There are times when fascia lata or

silk ligament suspension is used instead of or to supplement tendon transplantation

In all cases the transplanted muscle must be *powerful* must be in the immediate *vicinity* of the paralyzed muscle, and the original function of the muscle to be transplanted must be less essential than its intended new function. The new direction of the muscle from origin to insertion must be as nearly a straight line as possible except where a pulley effect is used. The mesotendon or mesotenon is carefully preserved in dissecting the tendon for transplantation, and its new bed should be subcutaneous in a fatty areolar layer or through a tendon sheath. Unnecessary handling of the tendon by gauze or instruments must be avoided and a minimum time of exposure is conducive to better future function. It is therefore better technic to prepare the bed of insertion and the channel for the course of the new tendon before attempting to dissect out the tendon to be transplanted.

General mechanical, physiological, and surgical considerations may be summarized as follows:

1 Preliminary correction of deformities

2 Full power of the proposed muscle whose tendon is to be transplanted so that its dynamic force will be sufficient to carry on its intended function

3 The direction of force should be such as to form a direct line of pull, the only exception being in pulley or loop operations

4 Maintenance of the gliding power by preserving the mesotenon which helps to maintain the nutrition to the tendon as well as its gliding power

5 The new bed or channel should be through a tendon sheath or in a subcutaneous fatty areolar layer

6 The tension of the tendon must be accurately maintained until it is sutured to the point of anchorage

7 Anchorage through a drill hole in the bone is necessary. This is usually supplemented by sutures to the periosteum and adjacent tendons and by looping the tendon back on itself. Braided white silk sutures No. 4 are used

8 A circular cast maintains the corrected position. Generally, the first cast remains on approximately three weeks after which the writer does a redressment and applies a new cast. If only a tendon transplantation has been done six

weeks of immobilization is usually sufficient. If it is combined with an arthrodesis twelve weeks of immobilization is essential, a redressing being done three weeks after the operation.

9 A brace maintaining the corrected position should be worn for six to twelve weeks after the cast has been removed.

10 Physical therapy consisting of gentle efforts at muscle reeducation, assistive and resistive under water (hydrogymnastics) and table exercises and massage must be properly supervised and gradually increased.

OPERATIONS

HALLUX EXTENSUS

The deformity is that of hyperextension of the metatarso-phalangeal joint, with dorsiflexion of the big toe due to an

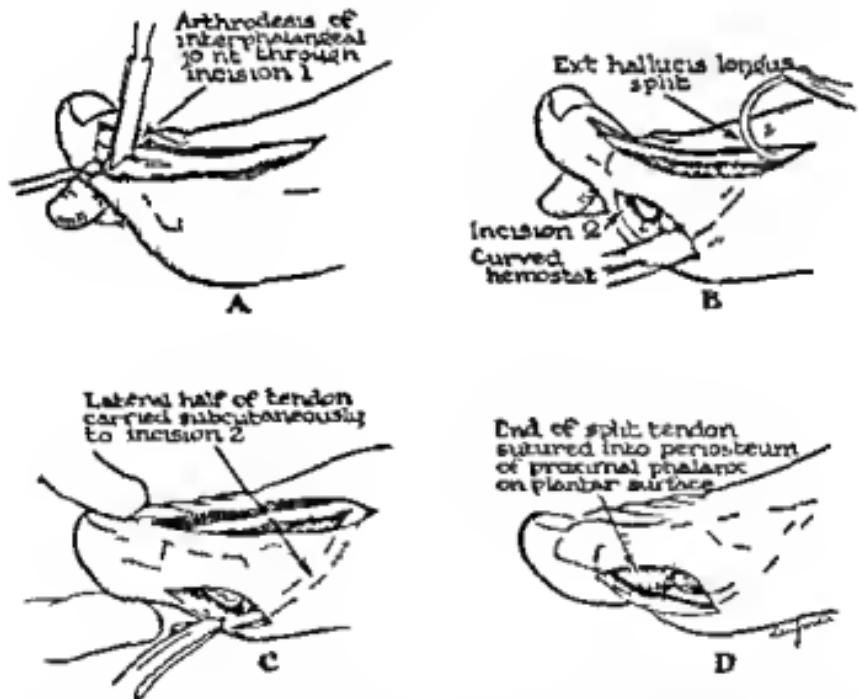


Fig. 38.—Hyperextension deformity of the great toe due to muscle unbalance. *A* Interphalangeal joint is arthrodesed. *B* Extensor hallucis longus tendon is split longitudinally and the medial half freed from its insertion. *C* Medial portion of tendon carried subcutaneously around neck of first metatarsal to flexor surface. *D* Free end of tendon sutured to periosteum of proximal phalanx on its flexor surface.

overactive extensor hallucis longus and brevis and a weak or paralyzed flexor group

Technic—Through an incision parallel with and somewhat medial to the extensor hallucis longus tendon, the interphalangeal joint is arthrodesed and the medial half of the insertion of the extensor tendon is severed, the tendon being split to a point approximately 1½ inches proximal to the metatarsophalangeal joint (Fig 38, A)

A second incision is made on the plantar medial surface of the proximal phalanx and the periosteum is reflected medially and laterally, the bone being roughened. A curved hemostat is bored along the course of the flexor tendon and around the neck of the first metatarsal, coming out at the proximal end of the first incision. The loose end of the extensor hallucis longus tendon is grasped and carried downward and distalward to be inserted by silk sutures into the periosteum of the proximal phalanx on its plantar surface (Fig 38, D)

Splitting of a tendon and expecting it to perform two functions is usually condemned but in this location and for this purpose the writer has found it very satisfactory

HOLLOW CLAW FOOT

The deformity is due to overactivity of the extensors of the toes and contracture of the plantar fascia and short flexors

1 Transposition or Translocation of the Extensor Tendons into the Shafts of the Metatarsals (Sherman)—
Technic—Through two longitudinal dorsal incisions the extensor tendons of the four toes are severed at the proximal phalanges and threaded through drill holes in the heads of the metatarsals the objective being to weaken extension of the phalanges and increase the dorsal pull on the metatarsal heads

manipulation to correct the cavus, and then by transplantation

of the extensor hallucis longus tendon into the head or neck of the first metatarsal bone (Fig 39, C) The interphalangeal joint of the great toe is arthrodesed Simple subcutaneous tenotomies and dorsal capsulotomies of the other extensor tendons and metatarsophalangeal capsules are done Firm gentle plantar flexion of the toes completes the correction A plaster cast from the toes to just below the knee maintains the correction for six weeks Ten days after operation the

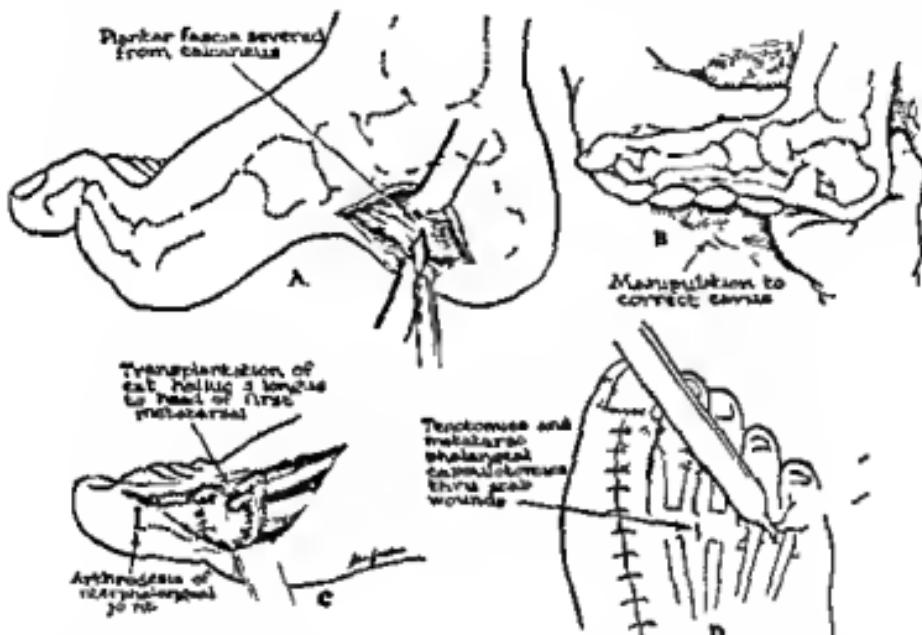


Fig 39—Hollow foot and claw toes. *A* Cutting plantar fascia. *B* Manipulation to correct cavus. *C* Arthrodesis of interphalangeal joint of the great toe and transplantation of the extensor hallucis longus tendon into the neck of the first metatarsal bone. *D* Subcutaneous tenotomies and capsulotomies of the extensor tendons and metatarsophalangeal capsules.

cast is reinforced on the plantar surface to permit weight bearing

PARALYTIC TALIPES VALGUS OR EQUINOVALGUS

1 **Transplantation of the Peroneus Longus Tendon to the Region of the Tibialis Anterior Tendon (Mayer) — Technic** — An incision is made over the insertion of the tibialis anterior tendon (Fig 40, A) The periosteum together with some cortical bone is dissected medially and laterally, exposing the medial or first cuneiform bone Drill holes are made

toward the center of this bone from above downward and from medialward inward, maintaining a wide bridge (Fig 40 B). These holes are enlarged with a small curet until the two connect.

A second incision 2 inches long is made just above the annular ligament in the course of the tibialis anterior tendon. The sheath is then opened. While some surgeons resect that portion of the tibialis anterior tendon which passes under the annular ligament in order to have sufficient space for the transplanted tendon the writer has found this unnecessary since the paralyzed tendon is soft and narrow and permits the peroneal tendon to pass alongside with ease.

A heavy blunt double eyed probe double threaded with braided white silk No. 4 is passed upward along the course of the tibialis anterior tendon emerging at the site of the second incision. The proximal end of the thread is carried through the drill hole the loop remaining within the second incision (Fig 40 A).

A third incision is then made along the course of the peroneus longus tendon winding behind the external malleolus to the base of the fifth metatarsal bone (Fig 40 C). The sheath of the peroneus longus tendon is opened throughout. In its upper 2 inches the anterior flap of the sheath is incised transversely in the proposed course of the new tendon. A longitudinal incision is also made in the fascia of the tibialis anterior muscle and its lateral portion is incised transversely, and sutured to the interior flap of the peroneus fascia to form a gliding bed for the new course of the lower end of the peroneus muscle belly (Fig 40 D). The peroneus longus tendon is severed as it bends under the lateral aspect of the foot. It is gently lifted from its bed exposing the filmy lace like mesotenon which extends down into the floor of the sheath. The mesotenon is cut as close to the tendon sheath and as far away from the tendon as possible. The mesotenon remains attached to and surrounding the peroneal tendon. The tendon is freed up to its muscular origin being careful to avoid vessels and nerves. A curved hemostat is then inserted into the upper end of the second incision and is directed laterally until it emerges through the areolar and fatty tissue overlying the tibialis anticus muscle belly where the new bed has

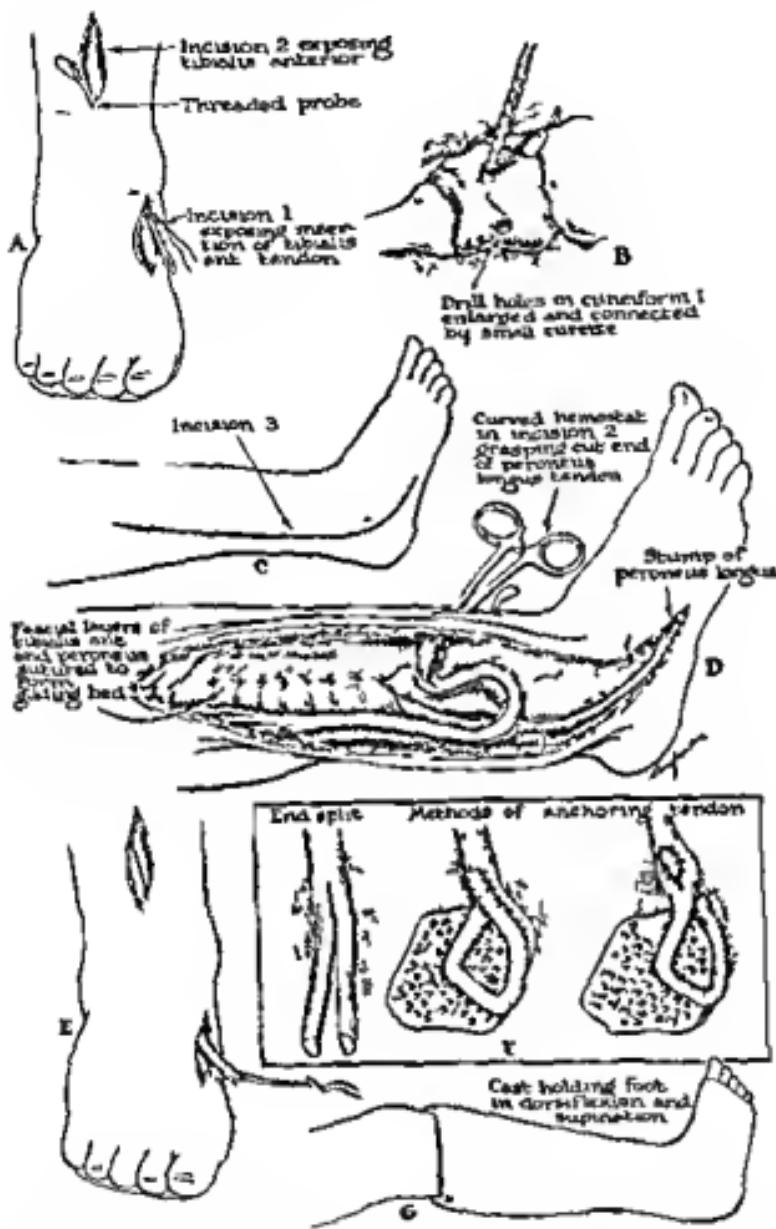


Fig. 40.—Transplantation of the peroneus longus tendon to the region of insertion of the tibialis anterior. *A*, Showing first and second incisions. *B*, Method of drilling for point of anchorage. *C*, Showing extent of third incision. *D*, Preparation of gliding bed, and method of delivery of tendon to incision number 2. *E*, Tendon carried under annular ligament to incision number 1. *F*, Methods of anchoring tendon. *G*, Circular cast holding foot in dorsiflexion and varus.

already been prepared. The tendon is grasped at its tip and *without rotation* gently carried through to the second incision.

which brings it within the sheath of the tibialis anterior tendon. Here it is fastened to the previously inserted silk loop and is carried through the bed of the tibialis anterior tendon to incision number one (Fig. 40, E). At this point the writer prefers to split the tendon into two limbs carrying one limb through the drill hole and looping it back to the main body of the tendon attaching it securely with number four

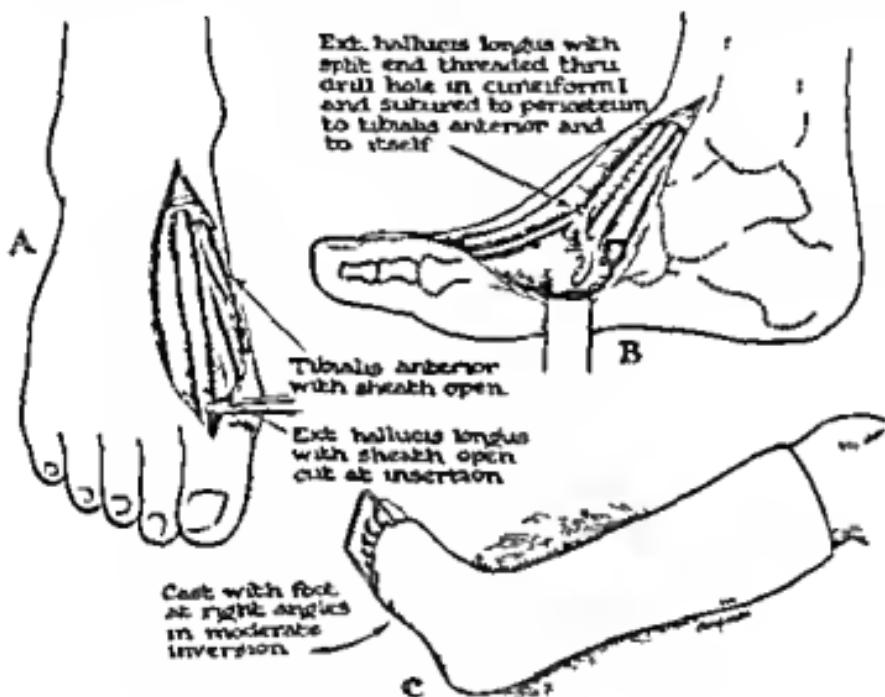


Fig. 41.—Transplantation of the extensor hallucis longus to the tibialis an-

C Cast

braided white silk and attaching the second limb to the periosteum and surrounding structures (Fig. 40 F). The tendon sheaths are closed with plain catgut No 00 and the skin is closed with a running suture of plain catgut No 0. A plaster of paris cast is applied from the toes to the knee maintaining the corrected position namely, dorsiflexion supination and inversion. The cast remains on for three weeks after which

it is bivalved and gentle massage started. At the end of six weeks the cast is removed and a brace applied which remains on for approximately three to six months. A night splint is used for many months.

If a tendon transplantation as described above is combined with an arthrodesis roentgenograms are made and a redressment is done three weeks after the operation. The cast remains on for twelve weeks from the date of operation. Five or six weeks after operation a window is cut in the cast over the belly of the peroneus longus muscle and gentle electrical stimulation is begun. After the cast has been removed a brace is fitted and a corrective shoe applied. Intensive physical therapy treatment is instituted.

2 Transplantation of the Extensor Hallucis Longus to the Tibialis Anterior—Technic—An incision is made parallel to the tendon of the extensor hallucis longus upward to the level of the ankle joint. The sheaths of the *powerful* extensor hallucis longus and the *paralyzed* tibialis anterior tendons are exposed, opened and retracted (Fig 41, A). The tendon of the extensor hallucis longus is split at the metatarso phalangeal joint and the medial half severed up to the navicular bone. Trauma to the hallux branch of the deep peroneal nerve must be avoided. A drill hole, as described above, is made in the first cuneiform bone. The free end of the extensor hallucis tendon is threaded through the drill hole and sutured to itself and to the tibialis anterior tendon using No 2 braided white silk (Fig 41, B). The floor of the combined tendon sheaths is reconstructed. The roof of the tendon sheath is then reconstructed. The skin is closed with plain catgut No 0. A cast is applied from the toes to the knee, the foot being held at a right angle and in moderate inversion. The after treatment is approximately the same as that described following the preceding operation.

PARALYTIC TALIPES VARUS

The deformity is due to an imbalance with a *powerful* tibialis anterior and tibialis posterior, and a *paralysis* of the peronei.

1 Transplantation of the Tibialis Posterior Through the Interosseous Membrane to the Cuboid Bone—Technic—A longitudinal incision is made over the cuboid bone (Fig

42, B) The periosteum is dissected medially and laterally exposing the entire dorsolateral surface of the cuboid bone

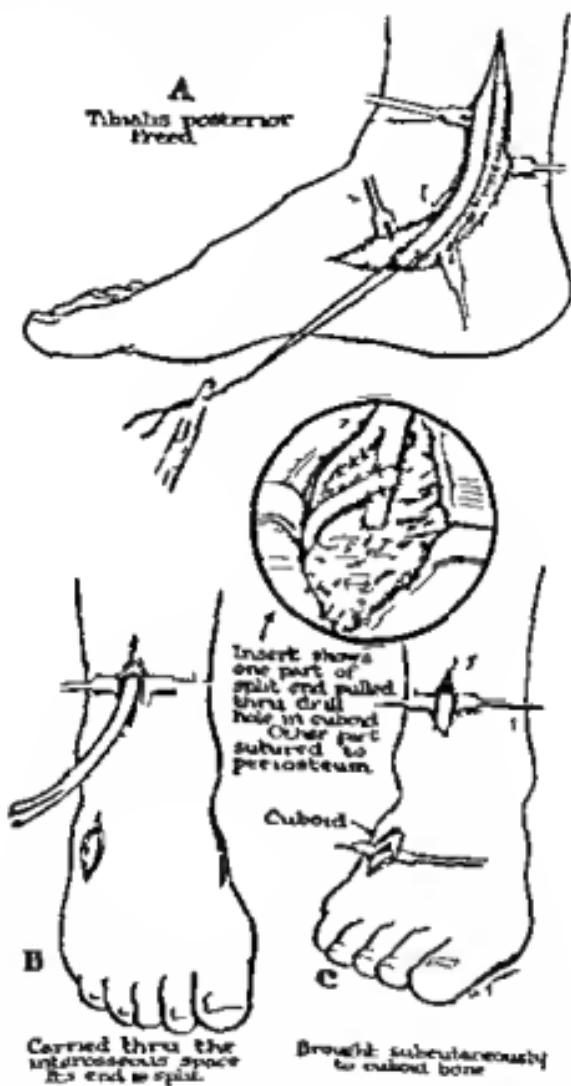


Fig. 42.—Transplantation of the tibialis posterior tendon through the in

Two staggered drill holes are made on the dorsolateral aspect and are caused to communicate by means of a small curet

A second incision approximately $1\frac{1}{2}$ inches long is made just above the annular ligament anterior to the fibula opening the fascia down to the interosseous membrane.

A third incision is made on the medial aspect of the foot ankle and lower leg parallel to the course of the tibialis posterior tendon from a point slightly beyond its insertion winding around the medial malleolus to about 6 inches above that point (Fig. 42 A). The tendon sheath is opened. The tibialis posterior tendon is detached from its insertion and from its bed preserving the mesotenon. The tendon is freed up to its origin from its muscle belly.

A curved hemostat is inserted into the second incision between the tibia and fibula through the interosseous membrane where it is spread producing a rather wide opening. The hemostat hugs the posterior aspect of the tibia and emerges through the medial incision. The end of the tibialis posterior tendon is grasped and carried through to this incision. It is then carried subcutaneously to the first incision where it is embedded into the drill hole in the cuboid bone and to its periosteum (Fig. 42 C) using No. 4 braided silk suture. While this causes the tibia to act somewhat as a pulley this operation has been uniformly successful in the treatment of talipes varus of postpoliomyelitic or spastic paralytic origin. The writer attributes his good results by this method to two factors: weakening of the invertor and plantar flexion force and strengthening the evertor and dorsiflexion force.

2. **Transplantation or Translocation of the Tibialis Anterior Tendon to the Cuboid Bone—Technic**—Another method for the treatment of paralytic talipes varus consists of the transplantation or translocation of the insertion of the tibialis anterior to the cuboid bone. In this operation the powerful tibialis anterior tendon is severed from its insertion and pulled upward through the annular ligament and then carried laterally and downward through the sheath of the extensor digitorum tendon and inserted into the cuboid bone (Fig. 43).

3. **Transposition of the Tibialis Posterior Tendon to a New Channel Anterior to the Medial Malleolus**—A curved incision is made along the course of the tibialis posterior

tendon from about 1 inch beyond its insertion to about 1¹/₂ or 2 inches above the medial malleolar tip. The skin flap is dissected anteriorly exposing the anteromedial surfaces of the ankle and foot. The sheath of the tibialis posterior is opened

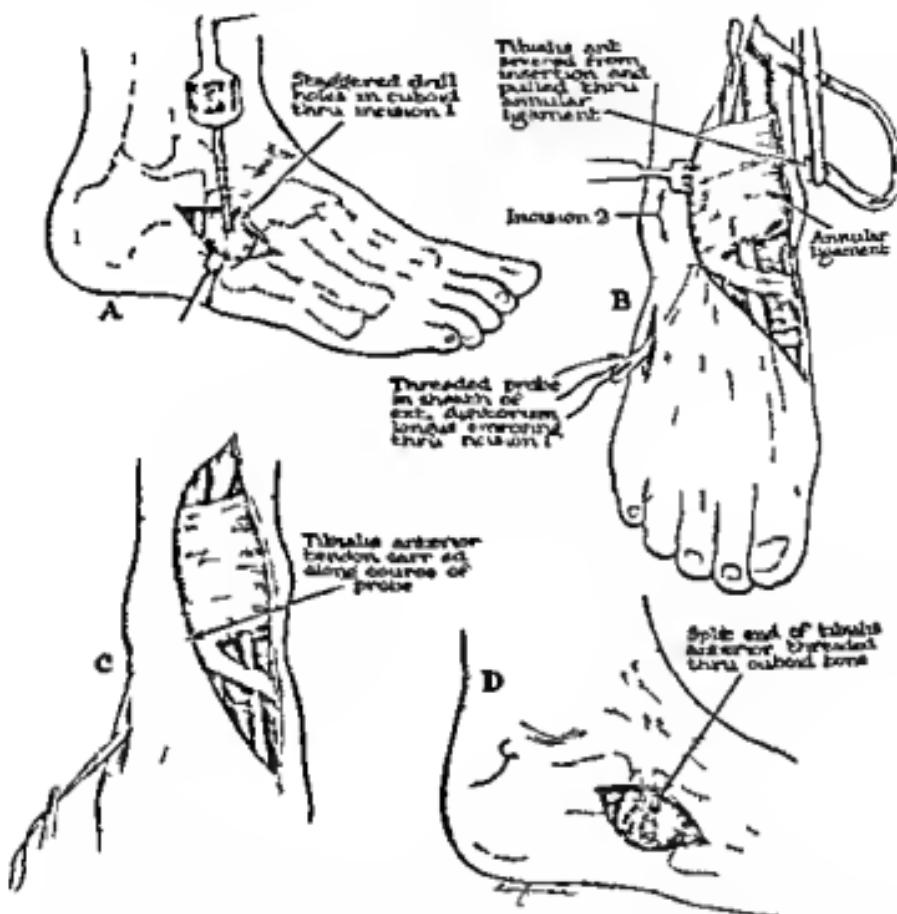


Fig. 43.—Transplantation or translocation of the tibialis anterior tendon to the cuboid bone. *A* Incision over cuboid bone. Preparation of drill hole. *B* Tibialis anterior tendon severed from insertion and pulled through annular ligament. *C* Tibialis anterior tendon carried through extensor digitorum sheath to first incision. *D* Attachment to cuboid bone.

throughout the course of the tendon. A bed is made anterior to the medial malleolus and consists of two flaps of the superficial layer of the annular ligament. The tibialis posterior tendon is gently freed from its bed and carried over the medial malleolus to its new bed. The fascial flaps reinforced

by superficial fascia are fastened over the tendon with interrupted sutures of fine chromic catgut (Fig. 44)

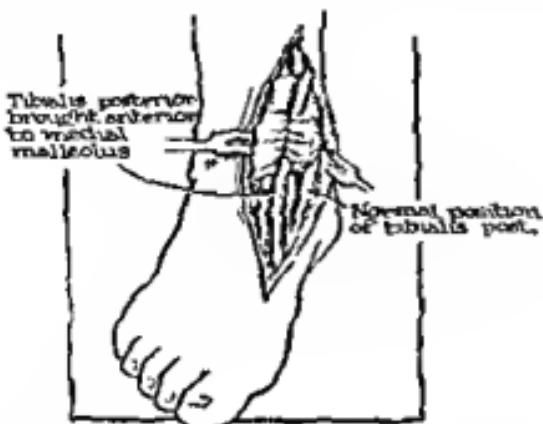


Fig. 44.—Transposition of the tibialis posterior tendon to a new channel anterior to the medial malleolus, using superficial layers of the annular ligament for the new channel

When the talipes varus is associated with some equinus, a Z plastic of the Achilles tendon supplements the above operations

TALIPES CALCANEUS WITH PES CAVUS

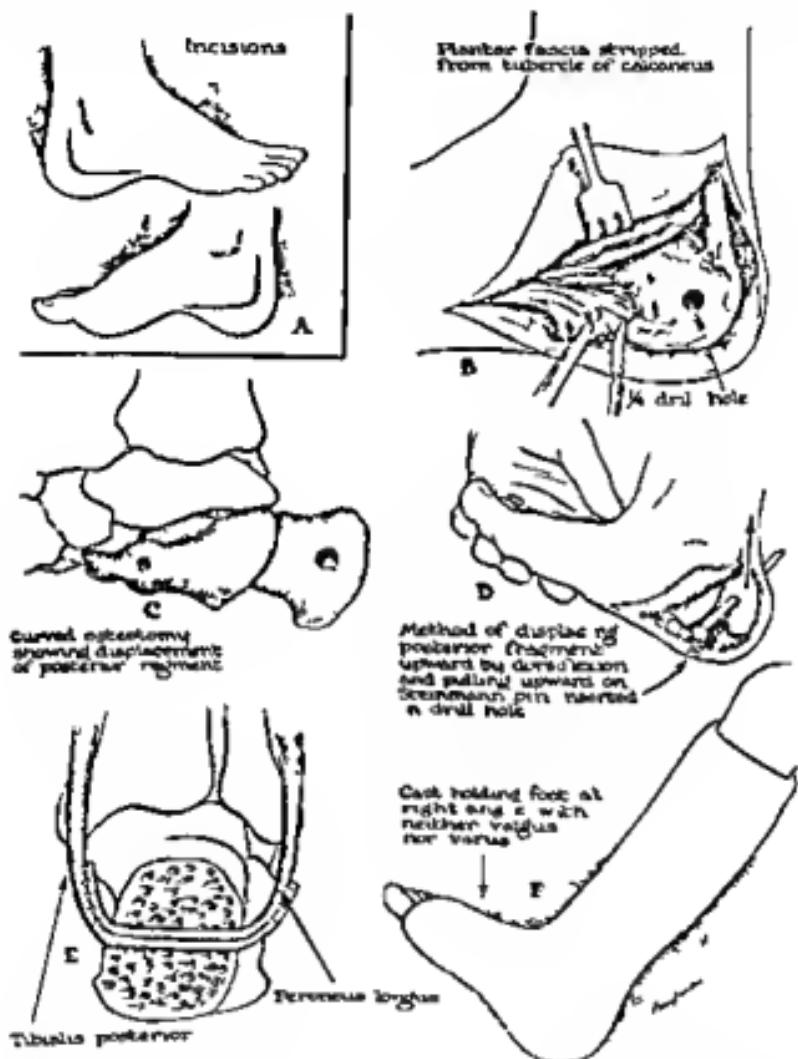
The deformity is due to paralysis of the gastrocnemius, soleus and plantaris (triceps surae)

Transplantation of the Tibialis Posterior and Peroneus Longus or Brevis to the Osteotomized Calcaneus—Technic—The first incision is made parallel to the plantar surface of the foot on its medial aspect, exposing the origin of the plantar fascia and short flaps. The calcaneus is thoroughly including the

B) A vigorous manipulative incision is carried slightly upward to expose the body of the calcaneus just posterior and inferior to the subastragalar joint. The skin flap is reflected upward exposing the course of

... to the distal of the fifth metatarsal bone. The tendons are retracted anteriorly and the calcaneus is exposed subperiosteally. A $1\frac{1}{4}$ -inch drill hole is made transversely in the posterior portion of the body of the calcaneus. A curved

osteotomy of the calcaneus is done (Fig 45 C) The foot is acutely dorsiflexed causing a relative upward displacement



Medial and lateral incisions
C Curved osteotomy of
fragment of calcaneus and
d peroneus longus tendons

threaded through drill hole in opposite directions and sutured under tension
F Cast

1.1.1
of the posterior fragment of the calcaneus. By inserting a Steinmann pin through the drill hole leverage is obtained to displace the posterior fragment of the calcaneus upward

(Fig 45, *D*) The foot is then replaced at a right angle to the leg. Sharp retractors beneath the posterior fragment maintain the upward thrust of this fragment while the tendons of the peroneus brevis (or longus) and the tibialis posterior are threaded through the drill hole in opposite directions under tension and sutured to each other producing a stirrup (Fig 45, *E*). The suture material used is No 4 braided white silk. The incisions are closed by layers with plain catgut No 0 and a plaster cast is applied with the foot at a right angle and neither varus nor valgus in which position it is allowed to remain for twelve weeks. The cast is then bivalved for active exercises, contrast baths and gentle massage. Weight bearing is not permitted until four to six months from the time of operation.

PARALYSIS OF THE QUADRICEPS EXTENSOR

1 Transplantation of the Biceps Femoris and Semitendinosus to the Patella.—*Technic*—When all of the flexors (hamstrings) are present, the best results are obtained by transplantation of the biceps femoris and the semitendinosus tendons to the patella.

A longitudinal incision 3 inches in length is made over the patella. The skin edges are retracted. The aponeurosis is exposed and split longitudinally on either side of the patella. A transverse drill hole or slot is made in the patella (Fig 46 *A*). An incision is made parallel to the biceps femoris from its insertion in the head of the fibula to the mid upper third of the thigh carefully avoiding the peroneal nerve which is isolated and gently retracted with a wet tape. The biceps tendon is carried anteriorly and medially by subcutaneous route to the first incision.

Another incision is made parallel to the semitendinosus tendon which is freed from its insertion to its muscle belly and carried anteriorly and laterally, subcutaneously and obliquely to the first incision overlying the patella. These tendons are sutured into the drill hole or trough and to the periosteum and the aponeurosis of the prepared bed overlying the patella (Fig 46 *D*). Braided white silk No 4 is used. The tissues are sutured with plain catgut and a cast is applied from the toes to the costal arch. The cast is removed after six weeks. A brace is applied permitting gradually increasing flexion.

osteotomy of the calcaneus is done (Fig. 45, C) The foot is acutely dorsiflexed causing a relative upward displacement

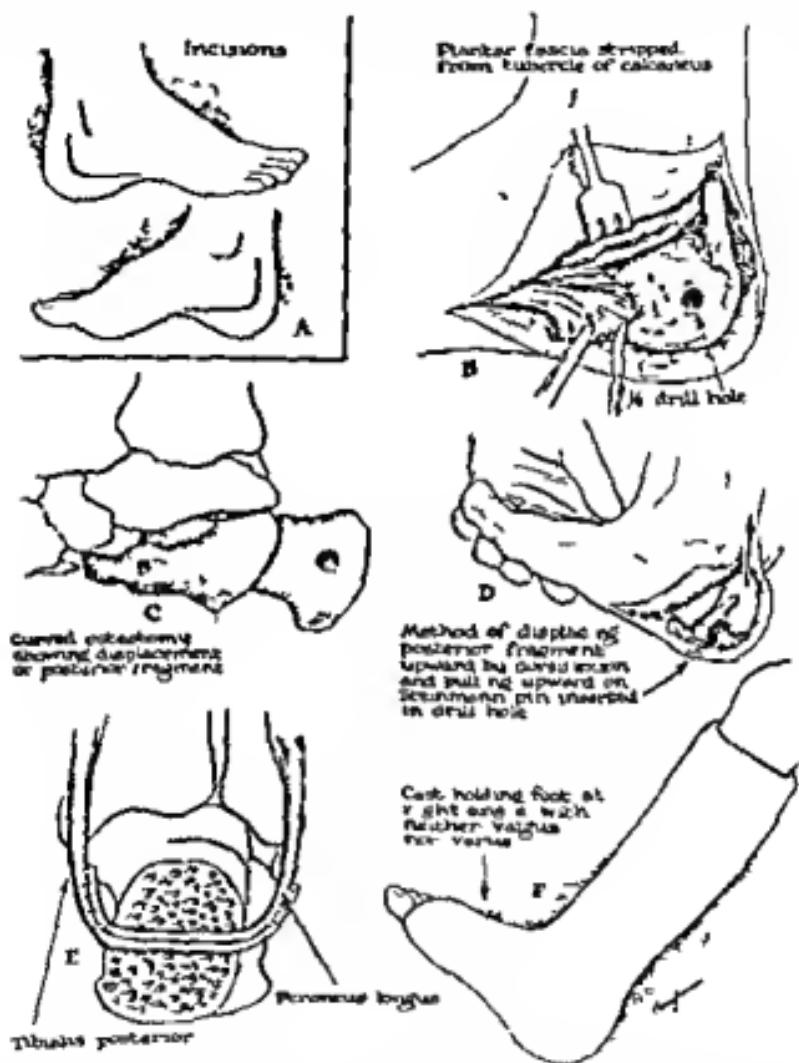


Fig. 45.—*Talipes calcaneus with pes cavus*. **A**, Medial and lateral incisions. **B**, Plantar fascia stripped. Drill hole in calcaneus. **C**, Curved osteotomy of calcaneus. **D**, Upward displacement of posterior fragment of calcaneus and manipulation of forefoot. **E**, Tibialis posterior and peroneus longus tendons threaded through drill hole in opposite directions and sutured under tension. **F**, Cast.

of the posterior fragment of the calcaneus. By inserting a Steinmann pin through the drill hole leverage is obtained to displace the posterior fragment of the calcaneus upward

FLEXION DEFORMITIES OF THE KNEES

This deformity is frequently observed in children with spastic paraplegia.

Transplantation or Translocation of the Patellar Tendon Insertion (Chandler) —*Technic* — Through an S shaped incision the aponeurosis covering the anterior aspect of the left knee joint to a point approximately 2 inches below the tibial tubercle is exposed. The skin is retracted. An incision is made through the aponeurosis parallel to the patella on both sides sloping gradually toward the patellar tendon to below the tibial tubercle. The tibial tubercle is removed together with its attached patellar tendon. The leg is forcibly extended and a square of bone on the anteromedial aspect of the tibia approximately $\frac{3}{4}$ inch below the previous insertion of the patellar tendon is excised. The tibial tubercle with its attached patellar tendon is inserted into its new bed. The bone of the new bed is transplanted to the site of the previous tibial tubercle.

This is called advancement of the insertion of the patellar tendon and increases the leverage of the extensor apparatus upon the leg. The transplanted tibial tubercle is impacted with a bone impactor and sutured to the periosteum and surrounding structures with No 0 chromic catgut or No 2 braided white silk or fastened with a staggered autogenous bone peg. The tissues are sutured with plain catgut including the skin. A plaster cast is applied from the costal margins to the toes. This is removed at the end of six weeks following which physical therapy consisting of hydrogymnastics, massage, active and passive exercises is instituted. A brace is used in the daytime and a night splint is used for many months.

TENDON TRANSPLANTATION FOR RECURRENT DISLOCATION OF THE PATELLA

1. Medial Translocation of Tibial Tubercl with Attached Patellar Tendon.—*Technic* — An incision approximately 6 inches long is made parallel with and medial to the patellar tendon. The anterior capsule and the patellar tendon and tibial tubercle are exposed. A block of bone surrounding the tubercle with its attached tendon is separated from the tibia (Fig. 47 B). The tendon is dissected upward on both sides

2 Transplantation of the Biceps Femoris to the Patella.—Frequently the biceps alone is transplanted to the patella using the technic described above. The end results have been very satisfactory for locomotion and gait, but usually not quite sufficient to extend the limb against the full force of gravity.

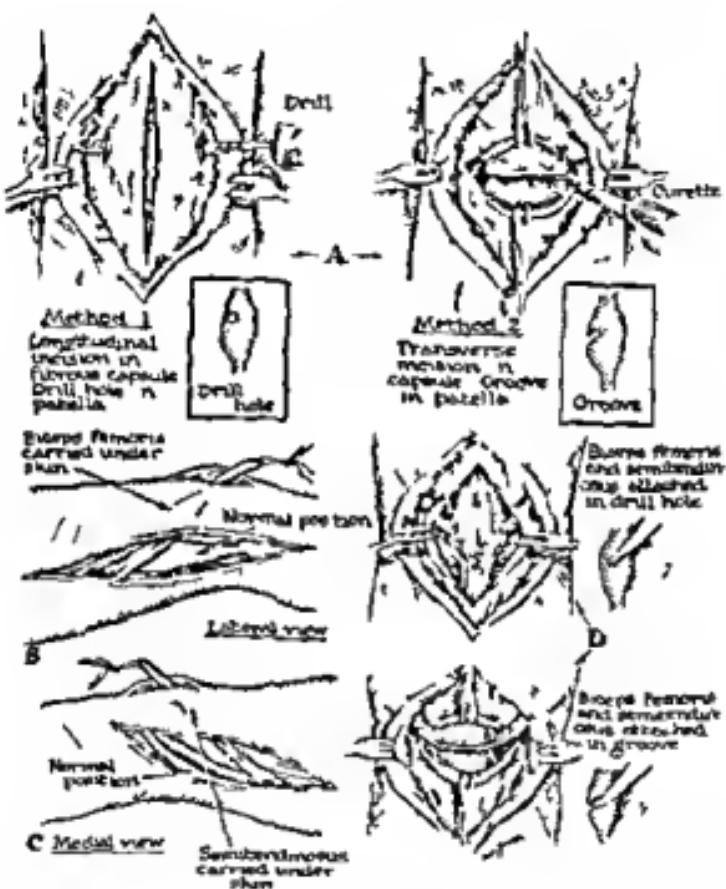


Fig. 46.—Paralysis of the quadriceps extensor. A, Showing methods of anchorage through drill hole or in transverse groove. B, Transplantation of biceps femoris to patellar incision. C, Transplantation of semitendinosus to patellar incision. D, Showing two methods of attachment of biceps and semitendinosus to the patella.

3 Transplantation of the Tensor Fasciae Latae to the Patella.—An operation similar to the above is done through a lateral incision utilizing a band of the tensor fasciae latae. Occasionally both the tensor fasciae latae and sartorius are transplanted to the patella.

ries the direction of force of the extensor apparatus medially. An autogenous bone peg from the tibial surface or a Sanderson screw holds the tubercle in its new location (Fig. 47, D). The fascia is sutured with chromic catgut No 0 and the skin is

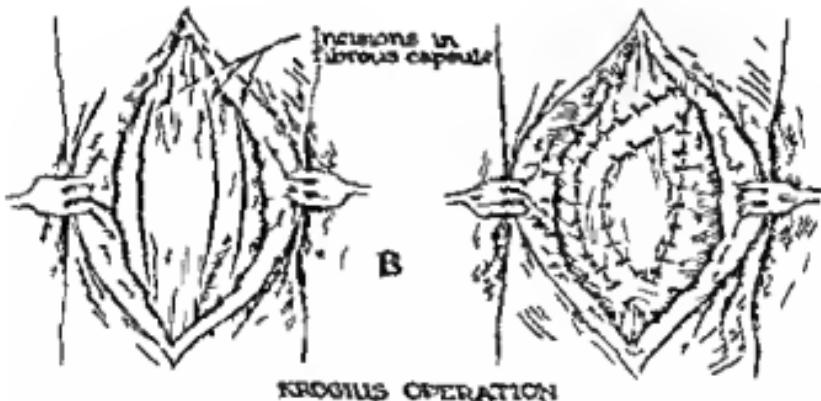
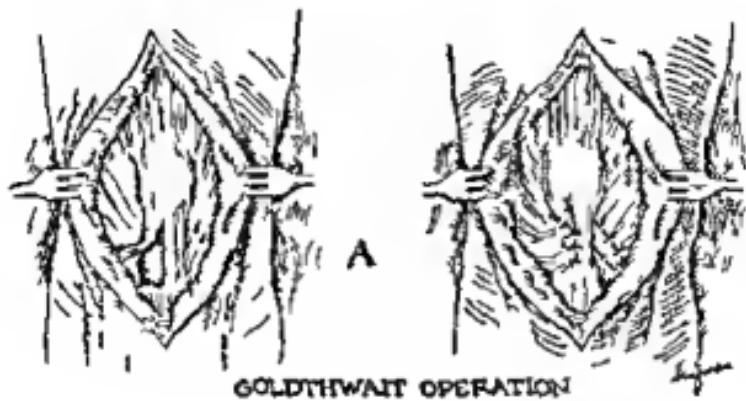


Fig 48—Recurrent dislocation of the patella. A Transplantation of outer half of the patellar tendon medially (Goldthwait). B Transposition of a bucket handle portion of the medial capsule to the lateral aspect of the patella (Krogdus).

sutured with plain catgut No 0. A plaster cast is applied from the toes to the costal arch incorporating the Sanderson screw. The latter is removed through a small window in three or four weeks. The cast is removed in six to eight

for a distance of approximately 2 inches or to the inferior surface of the patella. Occasionally when there is a congenital anomaly of the vastus medialis insertion the fascial incision extends upward to include the medial border of the patella where the aponeurosis of the quadriceps tendon is freshened

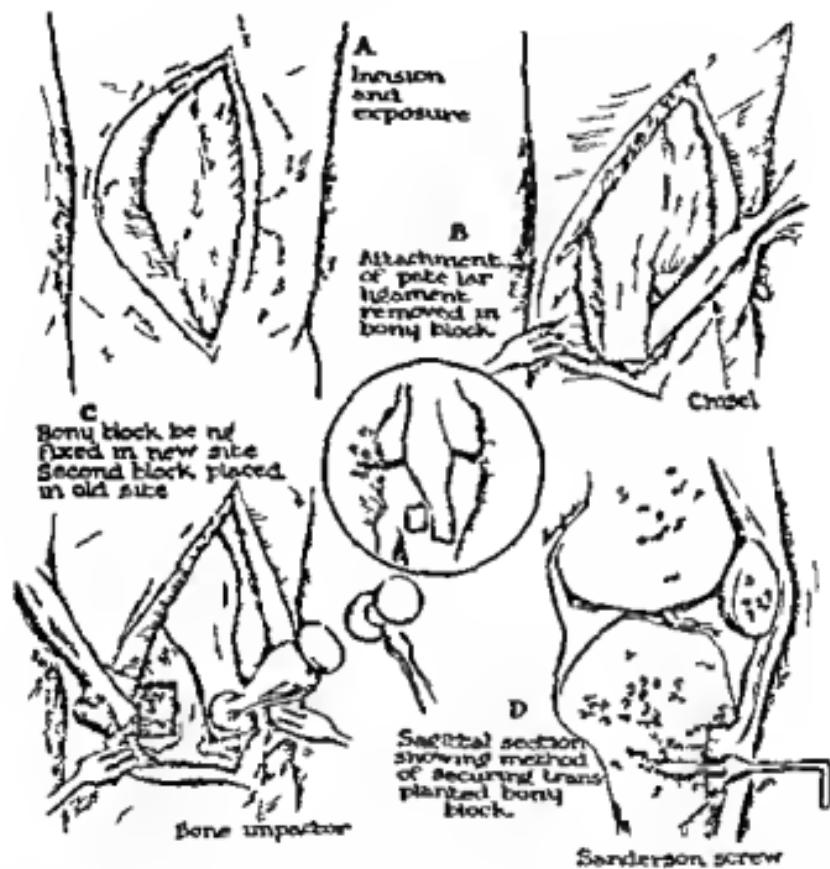


Fig. 47.—Recurrent dislocation of the patella. A Exposure of patella and tibial tubercle. B Detachment of tibial tubercle with patellar tendon. C Translocation of tibial tubercle to medial aspect of tibia. D Fixation of tubercle with Sanderson screw.

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the anteromedial surface of the tibia about $\frac{1}{2}$ to 1 inch medial to the location of the tibial tubercle. The blocks of bone are interchanged and impacted (Fig. 47 C). This car

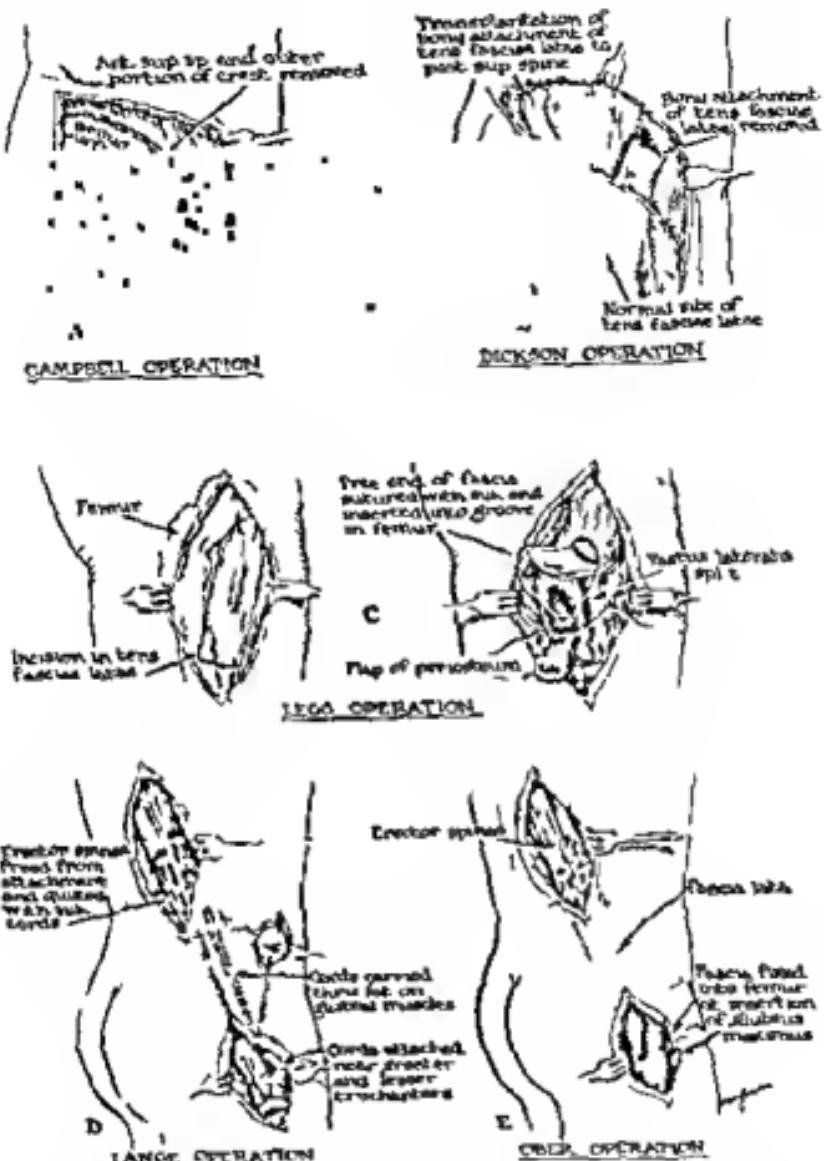


Fig. 49.—Operations for paralysis in the region of the hip. *A*, Detach-
ment of anterior superior spine of the ilium and the crest with muscles, and
transplantation to supra acetabular region (Campbell). *B*, Transplantation of
the tensor fasciae latae origin to the region of the posterior superior spine
(Dickson). *C*, Transplantation of the tensor fasciae latae into the subtro-
chanteric region of the femur for weakness of the gluteus medius (Legg). *D*,
Substitution of the erector spinae muscle for gluteus medius and maximus par-
alysis using heavy silk bridging suture from the erector spinae to the region of
the trochanters (Lange Kreuscher). *E*, Substitution of the erector spinae and
tensor fasciae latae for gluteus maximus paralysis freeing the lower end of the
erector spinae and turning up a long flap of fascia lata, which is threaded
through a drill hole below the great trochanter, and carried upward and at-
tached to the erector spinae with braided white silk (Ober).

weeks and is followed by physical therapy consisting of hydro-gymnastics, table exercises, heat and massage.

2 Transplantation of the Outer Half of the Patellar Tendon to the Medial Surface of the Tibia (Cross legging) (Goldthwait) — This operation consists of splitting the patellar tendon longitudinally, detaching the outer half from its insertion and passing it under the inner half, attaching it under tension to the periosteum and the aponeurosis of the sartorius with No 2 braided white silk sutures (Fig 48 A). A plaster cast is applied for six weeks.

3 Transplantation of a Bucket-handle Medial Strip of Capsule to the Lateral Aspect of the Patella (Krogus) — Through a long medial parapatellar incision the entire aponeurosis anterior to the knee joint is exposed. Two parallel incisions are made skirting the medial border of the patella. A strip of fascia about $\frac{3}{8}$ to $\frac{1}{4}$ inch wide is undermined but remains attached above and below (Fig 48 B).

Another fascial incision is made parallel to the outer border of the patella. The patella is retracted medialward and the strip of fascia from the medial aspect is translocated to the lateral aspect giving greater width to the lateral capsule. The fascia is sutured with fine chromic catgut No 0 on the lateral aspect and No 1 on the medial aspect which requires more tension to hold the patellar aponeurosis to that of the vastus medialis (Fig 48 B). The limb is placed in a circular plaster cast for six weeks followed by physical therapy consisting of whirlpool muscle-setting exercises, heat massage and gradually increasing motion.

4 Transplantation of the Tendon of the Gracilis or Semitendinosus to the Medial Border of the Patella Is an Operation That Has Helped to Increase the Medial Pull of the Extensor Apparatus

It is obvious that contributing bony deformities such as severe genu valgum or deformed lateral condyles may require correction to secure a successful result in some cases of recurrent dislocation of the patella.

OPERATIONS IN THE REGION OF THE HIP

Time and space in this clinic do not permit a detailed description of the operations in the hip region. Figure 49 with its legend illustrates the following operations:

CLINIC OF DR. EMIL HAUSER

PASSAVANT MEMORIAL HOSPITAL

MUSCLE IMBALANCE OF THE FOOT

MUSCLE imbalance of the foot may be due to any one of three things, namely, a decompensation in function, loss of power in one group of muscles with retention of power in the opposing group, or a mechanical alteration in muscle pull.

There is a normal balance between the work required of a muscle and its ability to carry out that work. A muscle imbalance will arise when the load is too great, or the capacity of the muscle is below normal. A muscle imbalance will certainly occur when both these factors are present simultaneously, and this combination is the most frequent cause of muscle imbalance of the foot. An example of an excessive load is the salesman who carries heavy sample cases. An increase in load may be due to a sudden increase in body weight, as with pregnancy. There is an abnormal amount of work required of the foot in certain occupations. The prolonged standing required of the salesgirl, the waiter or the policeman frequently gives rise to a muscle imbalance of the foot.

An example of muscle imbalance due to a decrease in capacity is the chronic invalid who through his prolonged bed rest has sustained a disuse atrophy of the muscles of the foot. Ill clad feet or shoes that do not permit normal use of the foot and thus prevent proper development, are a common cause of loss of capacity due to disuse. Lack of exercise, particularly walking is common in civilized urban areas. The automobile has been an important factor in discouraging normal exercise for the foot, resulting in a lack of development in the muscles of the foot. Such underdeveloped feet can no longer meet the normal requirements. When the normal requirement is demanded, a muscle imbalance manifests itself.

- 1 Transplantation of the anterior superior spine and the crest of the ilium for flexion contracture of the hip (Campbell Soutter)
- 2 Transplantation of the tensor fasciae latae origin to the region of the posterior superior spine (Dickson)
- 3 Transplantation of the tensor fasciae latae into the subtrochanteric region of the femur for weakness of the gluteus medius (Legg)
- 4 Substitution of the erector spinae muscle for gluteus medius and maximus paralysis (Lange Kreuscher)
- 5 Substitution of the vastus lateralis for the gluteus medius by silk strands to the iliac crest (Lange)
- 6 Substitution of the erector spinae and tensor fasciae latae for gluteus maximus paralysis (Ober)

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PASSAVANT MEMORIAL HOSPITAL

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There is a normal balance between the work required of a muscle and its ability to carry out that work. A muscle imbalance will arise when the load is too great or the capacity of the muscle is below normal. A muscle imbalance will certainly occur when both these factors are present simultaneously and this combination is the most frequent cause of muscle imbalance of the foot. An example of an excessive load is the salesman who carries heavy sample cases. An increase in load may be due to a sudden increase in body weight as with pregnancy. There is an abnormal amount of work required of the foot in certain occupations. The prolonged standing required of the salesgirl, the waiter or the policeman frequently gives rise to a muscle imbalance of the foot.

An example of muscle imbalance due to a decrease in capacity is the chronic invalid who through his prolonged bed rest has sustained a disuse atrophy of the muscles of the foot. Ill clad feet or shoes that do not permit normal use of the foot and thus prevent proper development are a common cause of loss of capacity due to disuse. Lack of exercise particularly walking is common in civilized urban areas. The automobile has been an important factor in discouraging normal exercise for the foot resulting in a lack of development in the muscles of the foot. Such underdeveloped feet can no longer meet the normal requirements. When the normal requirement is demanded a muscle imbalance manifests itself.

Muscle imbalance in the foot due to loss of power in one group of muscles and retention of power in the opposing group is most frequently caused by residual anterior poliomyelitis. Characteristic of this disease is a bizarre involvement of paralysis. Certain groups of muscles are paralyzed while others remain intact. Another example of muscle imbalance of this type is due to paralysis following a traumatic nerve injury. The power of the muscles supplied by the involved nerve is lost while the other muscles, including the opponents, retain their normal capacity. The result is an imbalance between two groups of muscles. A minor paresis of a muscular group may be compensated for by hypertrophy of the remaining active muscular fibers. With a severe paralysis, the capacity of the group involved is decreased below its normal demand. Such a loss of power must result in an imbalance between the involved muscle and its opposing group.

Normally there is a physiological balance between muscle groups. For instance the action of the dorsiflexors of the foot is balanced by the action of the plantarflexors or the posterior group. Although the posterior group is much larger and stronger than the anterior group there is a physiological balance between the two. The effect of gravity and the higher functional demand of the posterior group in walking, running and jumping make a normal functional balance in these two muscular groups. An imbalance between two opposing groups of muscles will result in a contracture of the stronger group. For example if there is a loss of power in the dorsiflexors of the foot the posterior group or calf muscles will contract. The result will be a plantarflexion or an equinus deformity of the foot. The presence of such a contracture over a long period of time will cause a stretching of the anterior group of muscles so that the normal fibers of this group will lose their power and increase functional loss.

Muscle imbalance in the foot due to mechanical alteration in the direction of the pull of the muscles is usually even secondary to a deformity. For instance in hallux valgus if the great toe is in the valgus position the abductor hallucis becomes displaced to the plantar surface and acts as a flexor of the toe rather than an abductor. The result is that the adductor hallucis loses its opposing force and contracts. At

the same time, with the toe in a marked valgus position, the extensor hallucis longus and flexor hallucis longus become displaced laterally and their action is not only to dorsiflex but also to adduct the great toe.

Another type of deformity that causes muscle imbalance is the valgus deformity at the heel. The altered relationship of the calcaneus to the talus changes the position of the insertion of the tendo achillis. This lateral displacement of the attachment of the tendon alters the pull of the muscle so that it acts as an evertor of the heel, as well as a plantarflexor. The additional power of the strong posterior group as an evertor sets up an imbalance between the pronators and supinators and results in a pronation deformity.

Muscle imbalance of the foot may thus be due to a compensation in function, loss of power in one group of muscles with retention of power in the opposing group, or a mechanical alteration in muscle pull, or it may be due to a combination of these causes. The causative factors are interwoven and two or all three may be present in the same case.

I am going to present 3 cases, each exemplifying one of the different types of muscle imbalance. The first case to be presented is an example of a muscle imbalance due to a functional decompensation.

Case I—A business woman aged forty five years complained of painful feet. The pain was constant and had been severe for two years. There was soreness at the base of the great toe and motion of this toe was limited. The legs ached and there was pain over the height of the longitudinal arch. The feet had been getting broader and longer and the toes were deformed. Corns had formed on the dorsa of the toes and these had been treated by a chiropodist. She had consulted a physician prior to this and x rays were taken which were reported as showing no abnormal findings. The condition of the feet was getting progressively worse and the pain had caused a disability.

Physical examination showed a well-developed woman who walked with a flat footed gait. Both feet were pronated and were held in eversion or external rotation as the weight was shifted from one foot to the other. The heel was in valgus position grade II on a basis of I to IV. The anterior part of the foot was spread grade III. There was hallux valgus grade II on the right and grade III on the left. An exostosis was present at the head of the first metatarsal bone near the metatarsophalangeal joint. Movements in all directions were limited at the metatarsophalangeal joint and an attempt at motion caused pain. There was a plantar callus present between the heads of the second and third metatarsal bones. The toes were contracted

in dorsiflexed position. The bursa over the first metatarsal head was swollen, red and tender.

Diagnosis was made of bilateral pes valgoplatus with hallux valgus bursitis, and a functional decompensation of the feet.

The treatment in correction of the deformity of the foot consisted of removal of the causative factors and reeducation of normal function. To correct the deformity the patient's shoes were padded. She was wearing street shoes with a so-called "Cuban heel". A felt pad was formed into an inclined plane that fitted under the longitudinal arch. The height of the pad corresponded to the height of the arch. The incline of the plane was directed toward the lateral side of the foot. A second pad was formed to fit the foot immediately posterior to the heads of the fourth, third, second and first metatarsal bones. It was shaped into an inclined plane with the slope directed medially. The height of the plane was beneath the fourth metatarsal bone and the incline descended to the first metatarsal bone. The pads were trimmed until they were comfortable and although she was conscious of their presence in the shoes they relieved her symptoms.

She was then advised to purchase a pair of corrective shoes with a straight inner sole, a low broad heel, thick leather sole and no metal shank. She was further advised to use hot applications and elevate the feet each evening until the inflamed bursa had subsided.

The next day she returned with the corrective shoes. These were tried to be sure that they fit properly and they were then padded and normal gait was taught. First the patient was told to hold herself as tall as possible drawing the abdomen in and elevating the chest, letting the shoulders fall back. Normal gait was then demonstrated and the patient imitated each step. One foot was placed forward so that the heel rested on the ground and the anterior part of the foot was in dorsiflexion. Then the body weight was rolled over the lateral side of the foot across the anterior part of the foot until the great toe assisted by the other toes contracted and propelled the body forward. The movement was a rolling motion from heel to toe with a screwlike twist from the outer side of the foot to the great toe medially and anteriorly. The foot was never flat, the heel and toe of the same foot were not allowed to rest on the floor at the same time during any phase of the gait. There was a spring in the gait. The toes pointed straight ahead. The gait was repeated several times and then the patient was instructed to practice it at home starting with periods of five minutes at a time several times a day. She was not allowed to wear the corrective shoes all the time. It was explained to her that the shoes were a mechanism to correct the position of the foot and to enable her to learn to use her feet correctly again. Each day the amount of exercise was increased until she could wear the shoes for four hours without difficulty.

She returned to the office after a week. The shoes were comfortable and further correction by means of external alterations on the shoes was advised. The heel was advanced $\frac{1}{8}$ inch under the longitudinal arch. The inner side of the heel was raised $\frac{1}{8}$ inch. A comma shaped transverse bar was fastened on the sole of the shoe posterior to the heads of the first, second, third and fourth metatarsal bones. There was a 2 inch space between the

transverse bar and the heel and $\frac{5}{8}$ inch between the bar and the outer margin of the sole. The bar was raised $\frac{1}{2}$ inch higher on the outer side than on the inner side (Figs 50-51). The advance of the heel supported the arch in standing since there was no steel in the shank of the shoe. The inclined plane of the heel of the shoe tended to correct the valgus deformity of the calcaneus. The raise on the outer side of the transverse bar tended to throw the anterior part of the foot into pronation. The distance between the heel and the bar is essential for phability and to permit the inclined planes to become effective. The distance between the bar and the outer margin of

Fig. 50



Fig. 51

Fig. 50—Corrective shoe showing the inclined plane of the anterior bar. This bar devised by the author in 1931 was first described in *Surgery of Minor Foot Conditions*. *Surgical Clinics of North America*, February 1938.

Fig. 51—Sole of corrective shoe showing the relationship of the transverse bar to the heel.

the shoe prevented raising the fifth metatarsal bone. The effect of bringing the heel into varus and the anterior part of the foot into pronation was to raise the longitudinal arch, straighten the great toe and reestablish a transverse arch with a narrowing of the foot. With these alterations on the shoe's normal gait was again taught. These corrections were an aid in carrying out the gait. The corrective shoes were worn only for five minute periods two or three times a day to start and the amount of use gradually increased so that at the end of the week she could wear them for an hour at a time. At the next visit a week later mistakes were corrected and normal gait was

again demonstrated. When seen two weeks after that the pain had subsided, the bursa was no longer inflamed she wore the shoes at home in the evenings to practice the correct gait.

Six weeks after the corrections had been applied to the shoes the patient developed a friction rub on the dorsum of the second toe of the left foot. This was relieved with the application of a felt pad immediately over the first phalanx of the second toe. The pad was worn for ten days and after that it was no longer necessary as the toes showed marked correction of the contracture deformity.

The patient was seen two months after the correction at which time she had complete relief of all her symptoms. She could walk several miles in her corrective shoes. She wore the corrective shoes whenever it was convenient, and for street wear she had Cuban heeled shoes with pads inside. For dress wear she had high heeled shoes with the transverse pad alone. The corrections on her shoes were altered so that the heel was $\frac{1}{8}$ inch higher on the inner side and the bar was raised so that it was $\frac{1}{4}$ inch higher on the outer side. She continued to wear the corrective shoes around the house for playing golf and for hiking and returned periodically to have the corrections altered. The pes valgoplatus has been completely corrected the hallux valgus is markedly improved the prominence due to exostosis of the head of the first metatarsal bone is still present. She plans to have surgical correction of this deformity at the first convenient time so that she may have completely normal feet.

The case described shows a muscle imbalance in the foot where the imbalance is due to a functional decompensation. The demand for work was greater than the capacity. This caused fatigue and beginning deformity of the foot. The cause of the decompensation was loss of strength due to continuous strain and interference with normal use as well as an increased load due to prolonged standing. This resulted in an altered relationship of the bones of the foot to each other. The calcaneus was displaced laterally at the talocalcaneal joint which gave rise to a valgus deformity at the heel. The tarsal bones were displaced into a pronated position, which expressed itself by the loss of the medial longitudinal arch. The metatarsal heads were spread apart from each other, which resulted in a splay of the anterior part of the foot. This is a typical pes valgoplatus deformity. The acute symptoms were relieved by elevation and hot packs. The pes valgoplatus deformity was corrected by means of corrective shoes, rest and corrective exercises. The capacity of the foot was increased so that the symptoms of decompensation were relieved entirely. The patient thus had a functional as well as an anatomical cure.

As an example of muscle imbalance in the foot due to loss of power in one group of muscles and retention of power in the opposing group, I am presenting the following case.

Case II—A young lady now eighteen years old was brought in for examination in July, 1933, when she was thirteen. Her parents brought her in on account of deformity of the left foot, and a lump. The lump was first noticed by the parents when the child began to walk. No history of typical anterior poliomyelitis could be established. The left leg was smaller than the right. The deformity of the foot had increased during the year prior to her coming in, a period which was associated with rapid growth of the child. She had had measles, mumps and scarlet fever all of which occurred after the onset of the trouble with her foot. Otherwise she felt well.



Fig. 52.—Deformity due to muscle imbalance as a result of residual anterior poliomyelitis

Examination showed a healthy appearing girl who walked with a limp. Examination by system showed normal findings except for the left lower extremity. There was noticeable atrophy of the thigh and leg. The quadriceps muscle was impaired grade II; the tibialis anterior was active but weak, grade II. The power in the peroneal group of muscles was lost. There was contracture of the soleus and gastrocnemius muscles. The foot was held in plantarflexion and inversion. The foot was shortened with an increase in the height of the arch. The plantar aponeurosis could be felt as a short, thick, tight band on the sole of the foot. The great toe was contracted and projected dorsally. The foot assumed a typical pes equinovarus position (Fig. 52). It was not possible to elicit the Achilles and patellar reflexes on the left side.

The patient was operated upon on August 11, 1933, at Passavant Hospital. Under general anesthesia the manipulative footboard was fastened to the left foot. The tourniquet was screwed down, stretching the plantar aponeurosis and flexor tendons and muscles. This was repeated several times. With the

footboard fastened tight the dorsal handle was used to apply force against the shortened tendo achillis. After the board was released and the manipulation repeated for the third time the foot was prepared for fasciotomy and tenotomy.

The tenotomy was inserted on the plantar surface of the foot placed under the insertion of the plantar aponeurosis and with the anterior part of the foot held to keep the aponeurosis under tension it was completely severed at its attachment. The flexor hallucis longus and flexor digitorum longus stood out under the skin as tight bands when an attempt was made to elongate the foot. The tenotomy was inserted at the points of most tension and the tight tendons and fascia were divided. This was done at three different points. The foot board was again applied and the force of the tourniquet exerted after the manner of a Spanish windlass until marked correction was obtained. The tourniquet was released to allow the circulation to return to the toes and then tightened again. The manipulation was executed three times.

Then the patient was turned so that the dorsal surface of the heel was up and placed so that the toes extended over the end of the operating table. A tenotomy was inserted on the medial side at the insertion of the tendo achillis and the medial two thirds of the tendon was divided. The tenotomy was withdrawn and inserted $1\frac{1}{4}$ inches proximal to the first puncture and on the lateral side the posterior fibers of the tendon and the lateral half of the tendon were severed with the tendon under tension. The fibers of the tendon were felt to slip and about 1 inch lengthening was obtained to bring the foot at right angles at the ankle joint.

A cast was applied to which a raise was attached underneath the heel and the patient walked in the cast on the third day. The heel for the cast was made of two ordinary rubber heels placed one on top of the other and attached with a 10 yard roll of 3 inch plasters of Paris. The child walked on the cast for six weeks after which time the cast was removed. The position of the foot as well as its appearance were greatly improved.

There was a tendency for recurrence of the old deformity particularly of the varus of the heel and the supination and adduction of the anterior part of the foot. This made for lateral instability of the foot. The imbalance between the dorsiflexors and plantarflexors was apparently corrected. It was decided therefore to fuse the talocalcaneal, the talonavicular and the calcaneocuboid joints to gain a stabilization. This was executed through a lateral incision. The fat was dissected all three joints were exposed and the cartilage on both surfaces of each joint was denuded. Care was exercised to denude both the anterior and posterior sections of the astragalocalcaneal or talocalcaneal joint. A second incision was made over the dorsum of the head of the first metatarsal bone. The extensor hallucis longus was identified and divided. The proximal end of the hallucis tendon was identified on the dorsum of the foot and the tendon was drawn out of its sheath. It was next looped around the tibialis anterior tendon. A small incision was made on the dorso-lateral side of the foot near the third cuneiform bone. A curved forceps was passed beneath the skin through this opening to grasp the end of the extensor hallucis longus tendon which was drawn and fastened to the denuded surface of the third cuneiform bone and the surrounding fascia. The junction of the tendon of the extensor hallucis longus and the tendon of the tibialis anterior

was then sutured with three sutures and the wounds were closed (Fig 53) Stockinet sheet banding and plaster of Paris were applied. The cast included the knee. The foot was elevated. Recovery was uneventful.

The patient was dismissed from the hospital on the tenth day. The cast was changed and sutures removed four weeks after the operation. A walking cast was applied and weight bearing was started at six weeks. The walking cast was worn for six weeks. The cast was removed and physical therapy



Fig. 53.—The extensor hallucis longus is looped around the tibialis anterior and attached to the outer side of the foot

carried out. The foot was bandaged with a 3 inch Tetra bandage and walking was permitted wearing shoes.

The patient presents herself now five years later with an excellent result (Fig. 54).

This is an example of muscle imbalance in the foot due to loss of power in certain muscle groups, with retention of power

footboard fastened tight, the dorsal handle was used to apply force against the shortened tendo achillis. After the board was released and the manipulation repeated for the third time the foot was prepared for fasciotomy and tenotomy.

The tenotomy was inserted on the plantar surface of the foot placed under the insertion of the plantar aponeurosis and with the anterior part of the foot held to keep the aponeurosis under tension it was completely severed at its attachment. The flexor hallucis longus and flexor digitorum longus stood out under the skin as tight bands when an attempt was made to elongate the foot. The tenotomy was inserted at the points of most tension and the tight tendons and fascia were divided. This was done at three different points. The foot board was again applied and the force of the tourniquet exerted after the manner of a Spanish windlass, until marked correction was obtained. The tourniquet was released to allow the circulation to return to the toes and then tightened again. The manipulation was executed three times.

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severed with the tendon under tension. The fibers of the tendon were felt to slip and about 1 inch lengthening was obtained to bring the foot at right angle at the ankle joint.

A cast was applied, to which a cage was attached underneath the heel and the patient walked in the cast on the third day. The heel for the cast was made of two ordinary rubber heels placed one on top of the other and attached with a 10 yard roll of 3 inch plaster of Paris. The child walked on the cast for six weeks, after which time the cast was removed. The position of the foot as well as its appearance were greatly improved.

There was a tendency for recurrence of the old deformity particularly of the varus of the heel and the supination and adduction of the anterior part of the foot. This made for lateral instability of the foot. The imbalance between the dorsiflexors and plantarflexors was apparently corrected. It was decided, therefore to fuse the talocalcaneal, the talonavicular and the calcaneocuboid joints to gain a stabilization. This was executed through a lateral incision. The fat was dissected all three joints were exposed and the cartilage on both surfaces of each joint was denuded. Care was exercised to denude both the anterior and posterior sections of the astragalocalcaneal or talocalcaneal joint. A second incision was made over the dorsum of the head of the first metatarsal bone. The extensor hallucis longus was identified and divided.

around the lateral side of the first and the second cuneiform bone. A curved forceps was passed beneath the skin through this opening to grasp the end of the extensor

arch supports of various kinds, but had no relief. There had been an inflammation at the base of the great toe and there was an enlargement in this area. The great toe on each foot had turned in until it was overlapped by the second toe, and the second toe on the left foot was contracted to form a hammer toe. The feet seemed to be getting larger. She was wearing longer and wider shoes than she had two years before.

Examination showed an enlargement over the head of the first metatarsal bone on each foot. There were calluses on the dorsal and lateral surfaces of the skin. The area was red and tender. The bursa was enlarged and inflamed. The head of the first metatarsal bone was rotated and projected medially. There was a marked hallux valgus, grade III on a basis of I to IV. The second toe overlapped the first toe. On the left foot the second toe was contracted to form a hammer toe. There was a callus on the dorsum of the proximal interphalangeal joint. In addition, there was a pes valgoplatus, grade III, and varicose veins. It was impossible to straighten the great toe so that it would be in alignment with the first metatarsal bone, and the attempt was painful. There was a contracture of the adductor hallucis obliquus.

Diagnosis was made of bilateral bursitis, hallux valgus splay foot and pes valgoplatus, with varicose veins and functional decompensation of the feet.

The treatment consisted, first, in the relief of the bursitis by means of elevation of the feet and the application of hot moist packs. Then the functional decompensation was relieved by means of the corrective shoes, and at the same time this corrected the pes valgoplatus deformity.

Conservative correction of the hammer toe on the left was carried out by means of a felt pad applied over the dorsum of the first phalanx of the second toe. This felt pad was $\frac{3}{8}$ inch thick, $\frac{1}{2}$ inch wide and $\frac{3}{4}$ inch long, and was held in place by adhesive so that the stocking and shoe could be put on without displacing it.

The varicosities were improved by the application of Unna paste boots.

Correct gait was carried out while the Unna paste boots and corrective shoes were worn. The action of the muscles in walking with the legs encased in the boots had a pumping effect, since with each contracture of the muscles the veins were emptied and with relaxation the blood supply to the muscles was increased. In this way the vascular tone was improved. After ten days the swelling had decreased and the boots had become loose, so new boots were applied. These were worn for a period of two weeks.

The patient was quite comfortable by this time, but the deformity of the great toe persisted. The hallux valgus and the projection of the first metatarsal bone distressed her, on account of the appearance of the foot and also because any attempt to wear an ordinary shoe would cause pain in this area. The deformity of the great toe was due to a muscle imbalance. The adductors were contracted and held the toe in extreme adduction while the function of the abductor was lost entirely. Due to the deformity of the toe, the abductor hallucis, which normally is placed on the medial side of the foot and great toe, was displaced so that it lay on the plantar side and acted as a flexor.

in muscles of opposing groups, which demonstrates that there is loss of function, deformity and instability of the foot. To regain function it was necessary to correct the deformity, and stabilization was then attained by means of fusion operation of the three joints involved in lateral movement of the foot. The muscle balance was attained first by weakening the powerful group as when the tendo achillis was lengthened the power of the posterior group was diminished. Muscle balance was further equalized by a tendon transplant. The attachment of the extensor hallucis longus was transplanted so that it acted as an abductor. At the same time it was attached to the tibialis anterior, which is a much more powerful muscle. The combined pull of the two muscles was balanced.



Fig. 54.—Corrected foot five years later

and brought the foot into dorsiflexion without permitting the foot to assume a pronation position. The palsy of anterior poliomyelitis is so varied that each case requires study to establish the best method to cure the muscle imbalance and re-establish the maximum function with the greatest improvement in appearance.

The third type of muscle imbalance in the foot where the imbalance is due to mechanical alteration in muscle pull is demonstrated by the following case.

Case III—A salesgirl twenty two years of age complained of pain in the joint of the great toe on each foot which had been present for two years previous to her coming in. She ascribed this pain in the feet to prolonged standing on hard floors. She had tried different types of shoes and had used

The abductor hallucis was then identified and freed at its insertion. The insertion of this tendon was then transplanted dorsally to the medial side of the base of the proximal phalanx. In this way the abductor hallucis was re-tored so that it could carry out its normal function. It no longer acted as a flexor but rather as an abductor.

The wound was closed and slight overcorrection was retained in the varus position. The position was held with a plaster of Paris cast. Both feet were operated upon in the manner described above.

The hammer toe in the left foot was also corrected at the same time. A dorsal incision was made and the extensor tendon was divided. The distal end of the proximal phalanx was resected and enucleated at the interphalangeal joint. The divided extensor tendon was then overlapped and sutured with a mattress suture bringing about a shortening of the extensor tendon and a retention of the correction reestablishing a muscle balance between the flexor and the extensor of the toe.

The convalescence was uneventful and on the seventh day the sutures were removed. The casts were then replaced with Unna paste boots. The patient was dismissed from the hospital on the ninth day wearing a slipper over the boot. She was able to walk short distances without pain. Ten days later she was able to wear her corrective shoes. The Unna paste boots were then removed and Tetra bandages applied and she continued to wear the corrective shoes. Heat and massage and reeducation of the muscles were carried out. The patient was able to work three weeks after the operation. She has continued to improve ever since there has been no tendency for the deformity to recur. She has been able to use the great toe in dorsiflexion and plantarflexion and balance between the abductors and adductors has remained normal. She now has relief of all her symptoms and wears dress shoes wearing the corrective shoes only at work because they are more comfortable for this purpose and they prevent foot strain.

This case represents a muscle imbalance in the foot on a mechanical basis. The position of the great toe was altered, resulting in an alteration in the muscle pull of the extensor hallucis longus and flexor hallucis longus as well as the abductor hallucis brevis and the adductor hallucis brevis. A tenotomy of the adductor hallucis correction of the deformity and transplantation of the abductor hallucis was necessary to reestablish normal muscle balance. A technic to bring about this correction which results in relief of symptoms and reestablishment of normal function and appearance was described.

Summary—Three types of muscle imbalance were set forth and a case was presented to exemplify each type. The method of treatment for each type was given in detail. The treatment resulted in improvement in function, relief of symptoms and correction of the deformity.

Extensor hallucis longus and flexor hallucis longus, which ordinarily course down the midline of the toe, were displaced so far laterally that they acted as strong adductors as well as extensors and flexors (Figs. 55, 56). Until this muscle imbalance could be corrected it would not be possible to carry out normal function nor correct the deformity. An operation was advised to correct the muscle imbalance.

A curved dorsal incision $1\frac{1}{4}$ inches long was made on the medial side of the foot starting at the level of the metatarsophalangeal joint and curving with the convexity toward the dorsum of the foot to end proximal to the head of the first metatarsal bone. The flap was turned back with sharp-knife dissection care being used not to enter the bursa nor puncture the skin. The bursa thus exposed was removed by sharp knife dissection. Through a small incision lateral to the base of the great toe the contracted capsule was divided



Fig. 55



Fig. 56

Fig. 55.—Hallux valgus with the altered position of the abductor hallucis and flexor hallucis longus.

Fig. 56.—Position of abductor hallucis and flexor hallucis longus following operative correction of hallux valgus.

interfered with the correction. For this reason an osteotome was used to remove the part of the head of the metatarsal that projected beyond the base

The abductor hallucis was then identified and freed at its insertion. The insertion of this tendon was then transplanted dorsally to the medial side of the base of the proximal phalanx. In this way the abductor hallucis was restored so that it could carry out its normal function. It no longer acted as a flexor but rather as an abductor.

The wound was closed and slight overcorrection was retained in the varus position. The position was held with a plaster of Paris cast. Both feet were operated upon in the manner described above.

The hammer toe in the left foot was also corrected at the same time. A dorsal incision was made and the extensor tendon was divided. The distal end of the proximal phalanx was resected and enucleated at the interphalangeal joint. The divided extensor tendon was then overlapped and sutured with a mattress suture bringing about a shortening of the extensor tendon and a retention of the correction reestablishing a muscle balance between the flexor and the extensor of the toe.

The convalescence was uneventful and on the seventh day the sutures were removed. The casts were then replaced with Unna paste boots. The patient was dismissed from the hospital on the ninth day wearing a slipper over the boot. She was able to walk short distances without pain. Ten days later she was able to wear her corrective shoes. The Unna paste boots were then removed and Tetra bandages applied and she continued to wear the corrective shoes. Heat and massage and reeducation of the muscles were carried out. The patient was able to work three weeks after the operation. She has continued to improve ever since there has been no tendency for the deformity to recur. She has been able to use the great toe in dorsiflexion and plantarflexion and balance between the abductors and adductors has remained normal. She now has relief of all her symptoms and wears dress shoes wearing the corrective shoes only at work because they are more comfortable for this purpose and they prevent foot strain.

This case represents a muscle imbalance in the foot, on a mechanical basis. The position of the great toe was altered, resulting in an alteration in the muscle pull of the extensor hallucis longus and flexor hallucis longus as well as the abductor hallucis brevis and the adductor hallucis brevis. A tenotomy of the adductor hallucis, correction of the deformity and transplantation of the abductor hallucis was necessary to reestablish normal muscle balance. A technic to bring about this correction, which results in relief of symptoms and reestablishment of normal function and appearance, was described.

Summary—Three types of muscle imbalance were set forth and a case was presented to exemplify each type. The method of treatment for each type was given in detail. The treatment resulted in improvement in function, relief of symptoms and correction of the deformity.

CLINIC OF DR. PHILIP LEWIN

COOK COUNTY AND MICHAEL REESE HOSPITALS

SURGERY IN INFANTILE PARALYSIS

It is impossible in the time allotted to go into a description of the many operations employed to correct the deformities left by infantile paralysis. I shall therefore present only a small group, indicating their purpose and indications as well as the contraindications and complications that might arise.

Before presenting the patients whose cases are reported in these clinics I shall outline some of the basic principles that govern the surgical considerations and operative treatment of the residual effects of infantile paralysis.

One should try to avoid operating on children under twelve years of age. As a rule no major operation should be performed within one or preferably two years of the acute attack.

The indications for operations are to improve function and stability, to correct deformity and to get rid of braces.

The surgeon must know the underlying principles and the mechanics involved in each problem so that he may plan an operation or a combination of operations to meet the individual requirements.

A blood pressure apparatus is used to render the field bloodless in upper extremity operations.

Acidosis may follow operations on patients who have had infantile paralysis. The prophylactic treatment is the administration of fruit juices, sweets and calcium. Curative measures include the intravenous use of dextrose and the free administration of fruit juices and lemon stick candy.

After orthopedic operations on the extremities the affected parts should be elevated and vigilance maintained to detect signs of swelling, discoloration and hemorrhage. Persistent pain is a warning.

Types of Operations—Operations on soft tissues include tendon lengthening tendon shortening tendon transplantation tenodesis muscle transplantation silk ligament suspension and fascial transplantation

Operations on bones include osteotomy, tendon fixation arthrodesis bone lengthening and shortening and epiphyseal arrest

Tendon Transplantation and Transposition—Tendon transplantation or transposition means the transference of the tendon of a functioning muscle to substitute for that of a paralyzed one. One must correct any existing deformity before he performs a tendon transplantation

Under the title of the physiological method of tendon transplantation in a series of three articles Mayer has given an excellent description of his technic emphasizing the importance of the restoration of the normal relationship between tendon and sheath. He describes the finer anatomy and physiology of tendons. He outlines the physiological requirements of a tendon operation and describes three typical physiological tendon transplantations (1) the transplantation of the extensor proprius hallucis as a substitute for the tibialis anticus (2) the conversion of the tibialis anticus into an abductor and pronator and (3) the transplantation of the peroneus longus to act as a substitute for the tibialis anticus.

Steindler's work on tendons is the application of the principles laid down by Lange and Biesalski and Mayer. Bernstein transfers the tendon together with its sheath and peritendinous structures. Royle devised a technic in which either the recipient tendon or the transplanted tendon is used as a living suture. Lange surrounds the tendon or silk tendon with parchment. The most common technic includes transplanting tendon to bone tendon to tendon and tendon to other soft tissue.

Tenodesis or Tendon Fixation—The anchorage of paralyzed tendons into grooves in bone was recommended by Galie. The method of fixation consists chiefly in turning up an osteoperiosteal flap suturing the tendon into the groove and replacing the flap. A paralyzed tendon is prone to stretch permitting recurrence of deformity. It must be maintained in proper position for a sufficient length of time. Foot drop may

be controlled by anchoring the extensor tendons into the anterior surface of the tibia. Gillie's tenosuspension operation for equinus is complicated and difficult. Varus may be corrected by anchoring the peroneals into the fibula. Valgus may

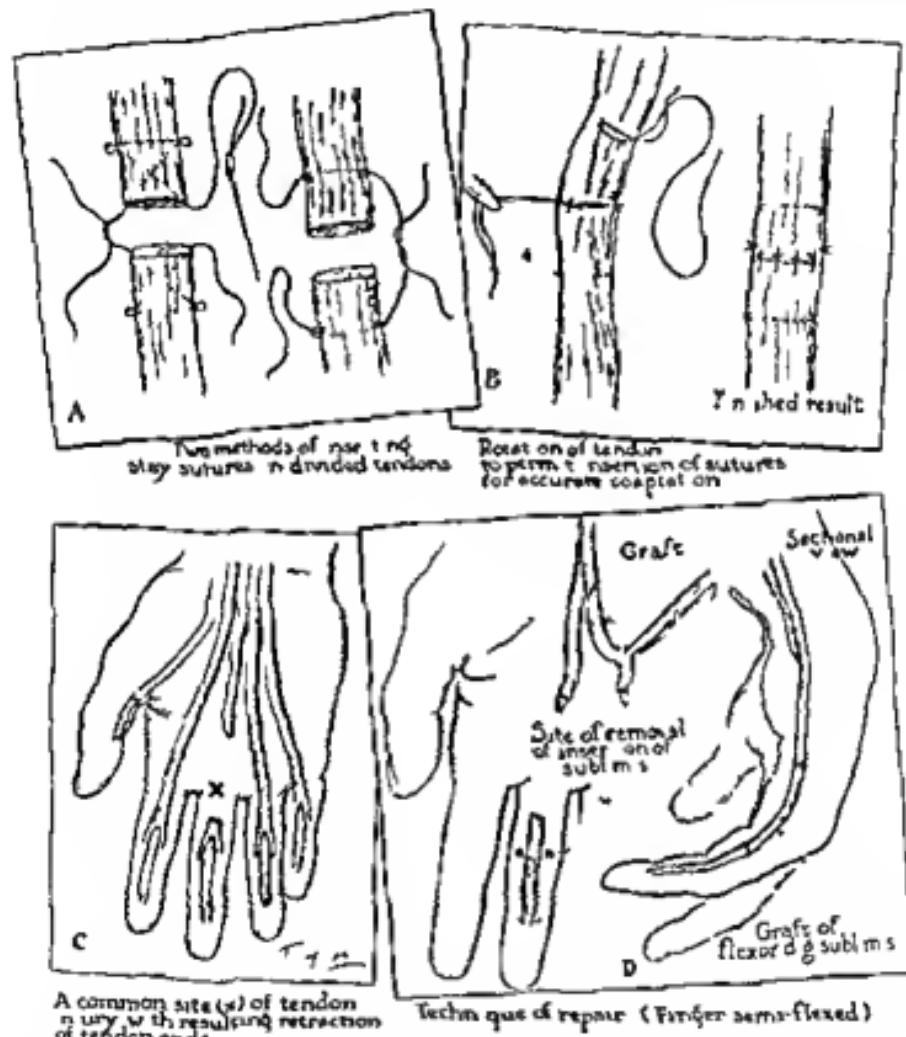


Fig. 57.—(Used by permission of Johnson & Johnson the copyright owners)

be corrected by anchoring the tibiales posterior and anterior into the tibia.

The principles of tendon transplantation require that the transplanted tendon must be nearly as strong as the transplantee, proper selection of site of implantation and determination of the route to be traversed. The tendon must not

angulate but should assume an oblique direction. A tunnel is usually made in the subcutaneous tissues. There must be accurate fixation to bone periosteum or to another tendon, fascia or muscle without too much tension or slack. The tissue should be handled gently. Hemorrhage is avoided by the use

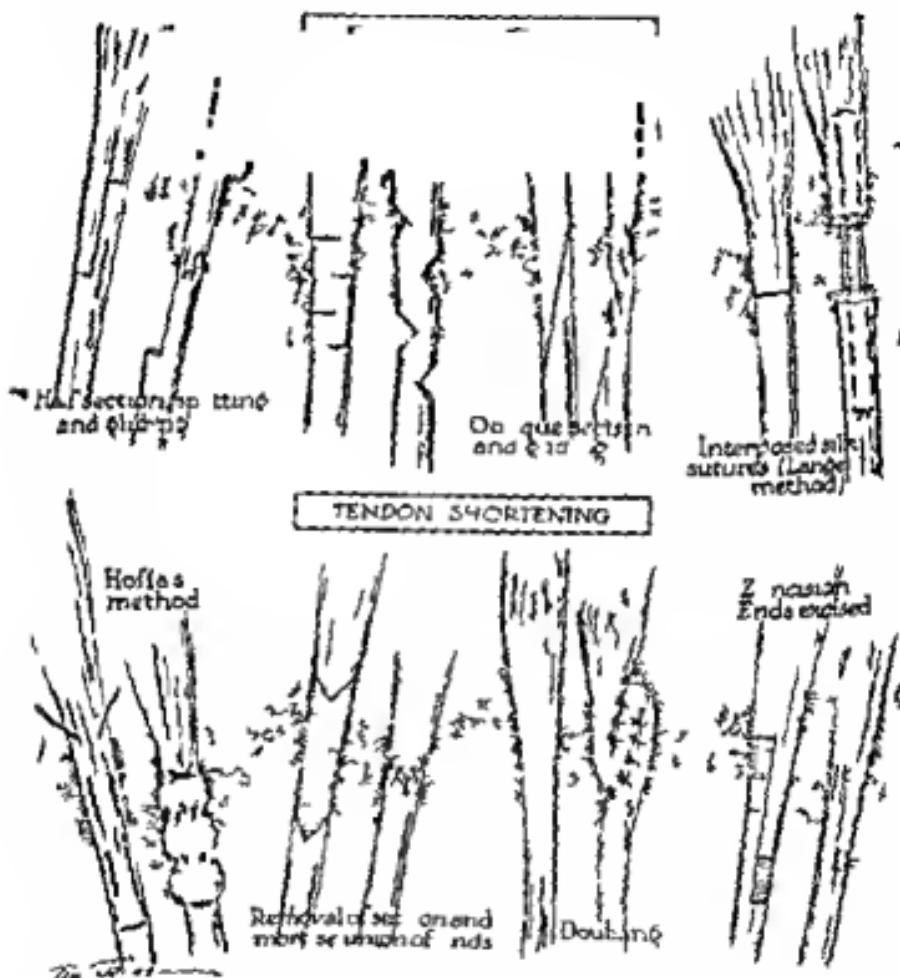


Fig. 55.—(Used by permission of Johnson & Johnson, the copyright owners.)

of a constrictor and careful dissection and moderate pressure of dressing to prevent oozing. The parts should be retained in proper position in braces, splints or plaster. The materials used for tenodesis are chromic catgut silk or metal screws. The postoperative care includes elevation of the limb, careful observation and early active movements within narrow limits.

Success depends upon whether the transposed tendon can be educated to perform its new function and the degree of tension under which the new tendon is sutured

A tendon suture should permit early function and must not strangulate the tendon. The suture which begins well back of the line of suture and merely grasps the tendon at three points on each side, gives sufficient purchase on the tendon to allow early motion. The chief operation of tendon transplantation of the hand is to substitute for loss of opposing action of the thumb and forefinger. In musculo-spiral paralysis with loss of extension of the wrist, fingers and thumb, one transplants the pronator *radii* teres, the flexor carpi *radialis*, and flexor carpi *ulnaris* to the extensors of the wrist, fingers and thumb. When the common and deep flexors are completely paralyzed one can transplant the active radial and ulnar extensors to the common and deep flexor tendons. If one replaces the short extensors of the thumb with a portion of the radial extensors of the wrist, recovery of function will follow, because abduction of the thumb is a movement closely associated with dorsiflexion of the wrist.

Stiles overcame paralysis of the intrinsic muscles of the hand which resulted in loss of power of normal flexion of the metacarpophalangeal joints in closing the hand, by attaching slips of the flexor profundus tendon to the lateral borders of the proximal phalanges. In paralysis of the thenar muscles, with loss of the opposing action of the thumb which seriously incapacitates the hand, Steindler replaces the action of the opponens pollicis by splitting the deep flexor tendon of the thumb and anchoring one half dorsally to the base of the first phalanx.

Bunnell's Operation.—Bunnell designed an operation to

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through a living tissue pulley constructed at the pisiform bone, and passed on subcutaneously to be attached to the tendon of the extensor pollicis longus.

In cases of paralysis of the extensors of the hand, the flexor carpi *radialis* is passed through the sheath of the extensor carpi *radialis longior* to the base of the second meta-

carpal bone. The flexor carpi ulnaris is directed subcutaneously to the tendon of the extensor carpi radialis. The short tendon can be sutured to the extensor tendon sufficiently near the insertion of the latter to give good operative results. This operation should never be performed alone, since the extensor carpi ulnaris has little extensor effect, except when combined with the extensor carpi radialis. The flexor sublimis digitorum is directed subcutaneously to the extensor communis digitorum or through the sheath of the extensores carpi radiales longior and brevior to the base of the second and third metacarpal bones. The latter operation is indicated, when extension of the fingers is possible but extension of the wrist is not. Transplantation of the index finger tendon of the extensor communis digitorum will substitute for the extensor tendon of a single finger. Transplantation of the adjacent flexor sublimis digitorum tendon will replace the flexor tendon of a single finger.

Foot Operations — The tibialis anticus tendon may be secured to the outer side of the tarsus and the extensor hallucis longus to take the place of the tibialis anticus. The posterior tibial and peroneal muscles are associated with the Achilles tendon in extension of the ankle and can be used to replace one another.

In cases of weakness of the anterior tibial group Dunn recommends tendon fusion of the anterior tibial muscles. He exposes all the anterior tibial tendons above the ankle, the fascia covering them is cleanly dissected away and opposing tendon surfaces are incised and the inner surface of the tendons exposed by dissection. The tendons are then united to one another.

Muscle Transplantation — Muscle transplantation is not practical.

Silk Ligament Suspension — The principle of this operation is that a silk ligament when used as a substitute for a tendon acts as a nucleus for connective tissue and produces a new ligament.

of the thigh

Arthrodesis — Arthrodesis means making a joint immov-

able by the fusion or consolidation of its component parts. It is one of the triumphs of orthopedic surgery. It was originated by Albert in 1879. The indications for arthrodesis are to correct deformity, increase stability and get rid of braces.

Arthrodesis is applicable to practically any joint in the body except the temporomandibular. It is especially valuable in the foot, knee, wrist, elbow, shoulder and spine.

The principles of arthrodesis demand:

1. An accurate approximation of bones like the fit of a cabinet maker.

2. Proper relationship of portions of the extremity to each other.

3. Retention in proper position until consolidation is complete.

The contraindications are youth and lapse of insufficient time after the acute attack.

In the foot the most important are the transverse tarsectomy of Davis, the subastragalar arthrodeses of Hibbs and Dunn, the operation designed by Hoke, the triple arthrodesis of Ryerson and the panastragaloid arthrodesis of Albee and Steinbier. The subastragalar arthrodesis is used as a stand ard operation and modifications of this general technic are indicated to meet special conditions.

Operations on the Upper Extremity—The two essential functions of the upper extremity are grasping with the hand and moving the arm. Flexion in the hand and fingers is necessary for the performance of manual labor, the trades, the arts and the routine of domestic life. Dressing, eating, writing, sewing and similar occupations are dependent upon flexor muscle activity. In addition to flexor power in the fingers for useful function it must be possible to move the scapula on the thorax which implies some power in the rhomboids, trapezius and serratus muscles. The minimum requirements for a successful operation on a paralyzed arm are flexion power of the hand and fingers and the ability to move the scapula on the thorax.

Deltoid Paralysis—The deltoid muscle is required to raise the arm from the side. The best operation in cases of deltoid paralysis to secure abduction of the arm is arthrodesis of the shoulder joint. This is of course effective only where

the muscles which move the scapula on the thorax have good power. After a successful arthrodesis of the shoulder joint with good trapezius, serratus, and rhomboid muscles, if the arm is retained in abduction and somewhat forward of the plane of the body, a very useful arm results, with good motion and power. The operation is not advised during early childhood (Fig. 59).

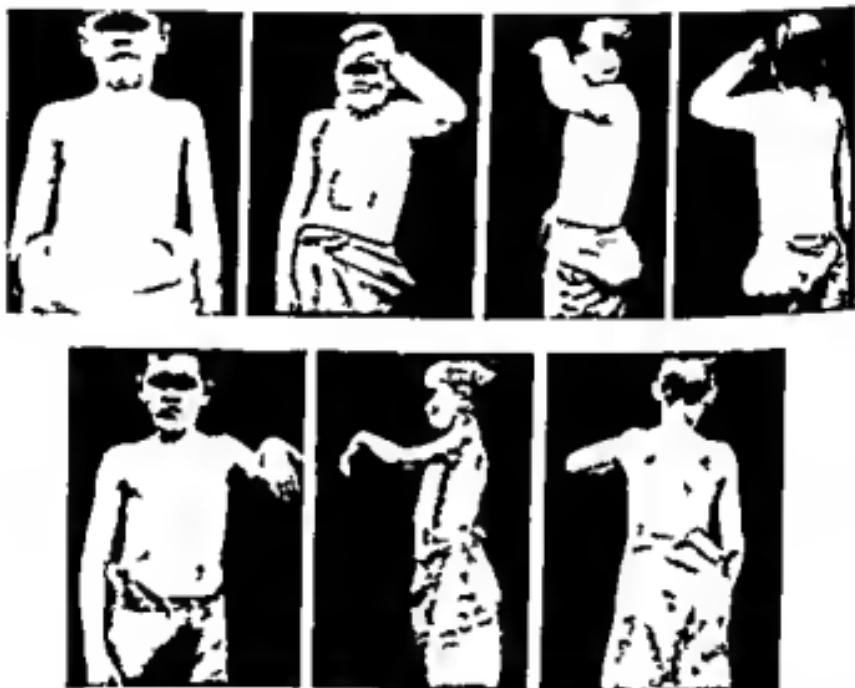


Fig. 59.—Arthrodesis of shoulder in a case of paralysis of left arm (Wrist drop to be corrected later.)

If the biceps muscle is paralyzed in addition to shoulder muscle paralysis, arthrodesis of the elbow is also desirable. The biceps muscle must be regarded as one of the highest importance. In cases of paralysis of the biceps, transplantation of the long head of the triceps, subcutaneously to the insertion of the biceps is advisable.

An arm with a stiff shoulder joint and a stiff elbow, with flexor power in the wrist and fingers and sufficient power in the scapular muscles to move the arm about is a useful member and infinitely preferable to the flail arm which hangs helpless at the side.

Many attempts have been made to correct paralysis of the

abductors of the shoulder. Only one procedure for paralysis of the abductors has been accepted as a standard procedure viz the arthrodesis of the shoulder.

Mayer however advises detaching the trapezius from its bony insertion lengthening it by an artificial tendon constructed of fascia lata and suturing this tendon to the humerus near the deltoid insertion. The presence of not only a strong trapezius and serratus magnus but also of one additional muscle—either the clavicular portion of the pectoralis major, the biceps or the coracobrachialis is a prerequisite to success.

If there is complete paralysis of the deltoid and good or normal power in the biceps and triceps Ober uses these two muscles in the following manner:

A saber incision is made over the shoulder the anterior leg extending down over the anteromedial aspect of the arm for 3 inches. The coracoid process of the scapula and the short head of the biceps are exposed. The tendon of the biceps with a small piece of bone is dissected free from the coracoid process and the muscle is cleared from above downward to the musculocutaneous nerve. The long head of the triceps is exposed through the posterior leg of the incision and its origin on the scapula together with a small piece of bone is removed and the muscle cleared from the upper fourth of the humerus.

The tip of the acromion is exposed and osteotomized on the flat at the tip the end being pried open. The free end of the triceps is carried up over the deltoid and sutured into the bone flap at the posterior aspect of the acromion and the biceps is carried up in a similar manner and sutured to the anterior end of the split acromion. Number 16 silk is used for suture material. These two tendons are sutured together for a distance of 1 inch from the tip of the acromion. The wound is closed with silk and the arm is put up at right angles on a platform splint (Fig. 60).

Haas supplements the plastic operation with a Kilian Nicola procedure similar to that employed in recurrent dislocation of the shoulder.

Let us review our surgical anatomy at this point. Mayer describes the mechanics of the shoulder as follows. In the normal person the first 90 degrees of abduction occurs almost entirely between the humerus and the scapula. The scapula

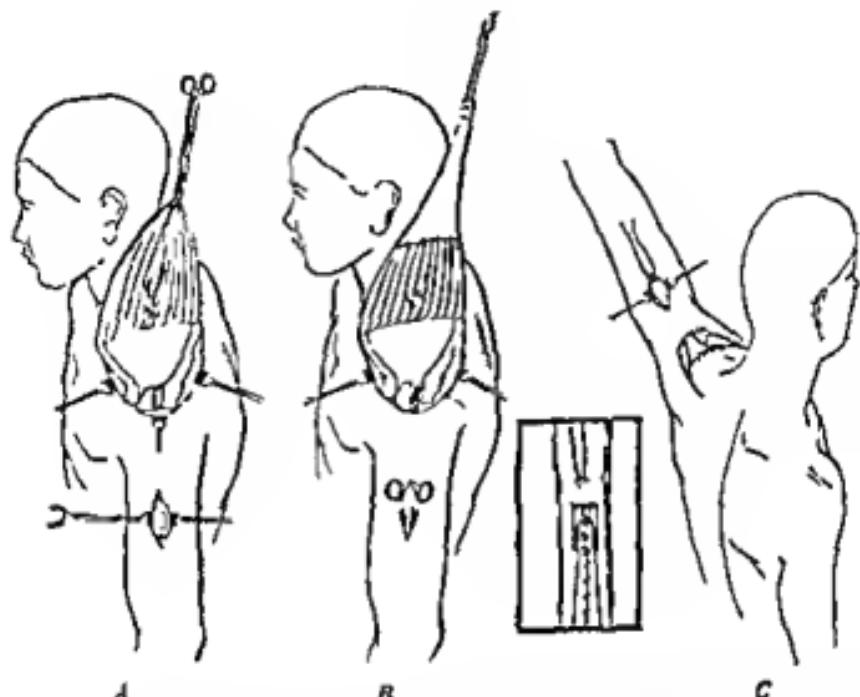


Fig. 60.—Transplantation of the trapezius for paralysis of the abductors of the arm. *A*, This drawing illustrates first, the dissection upward of the trapezius muscle until the blood vessels and nerves can be seen entering its deep surface, second, the portion of the acromion which has to be removed for the passage of the fascial transplant between the acromion and the shoulder joint (this portion of the bone is shaded) third the window cut in the humerus and the drill hole opening about $\frac{1}{2}$ inch below this. *B*, In this drawing the fascial transplant has been firmly sutured to the muscle by means of a series of interrupted chromic sutures. The fascia has been rolled on itself to form a strong tube. The sutures uniting the fascial edges do not show in this drawing since they are on the other side of the fascial tendon. The fixation suture for anchoring the tendon has already been inserted. A hemostatic forceps has been passed from the region of the deltoid insertion upward beneath the fibers of the deltoid and out near the acromion process. *C*, In this drawing the arm has been abducted 150 degrees preparatory to suturing the fascial tendon to the bone. The fascial tendon can be seen passing from the trapezius muscle downward beneath the acromion process and out near the insertion of the deltoid. The continuous suture bringing together the edges of the fascial strip is now visible. The insert is an enlarged view of the humerus to show in greater detail the way in which the fascial tendon is drawn downward within the medullary canal by means of the anchoring suture which passes out through a drill opening about $\frac{1}{2}$ inch below the window in the cortex (Leo Mayer, *Journal of Bone and Joint Surgery*, July, 1927).

itself remains almost immovable. During the next 90 degrees of motion the humerus and the scapula move together and the lifting motion of the arm is accomplished by a torsion of the scapula which moves through an arc of about 90 degrees. Subsequent to the trapezius transplantation by Mayer's method the process is reversed. During the first 90 degrees of motion the scapula moves with the humerus. After the arm has been abducted about 90 degrees the scapula remains immobile and the humerus is lifted upward through the action of the biceps or the coracobrachialis or if the clavicular portion of the pectoralis major is active through that muscle. The trapezius plays only a minor role during the second half of abduction of the arm.

Acromioclavicular Arthrodesis—Ankylosing operations on the acromioclavicular joint are followed by excellent results. The indications are pain and slipping of the joint which interferes with occupations or athletics. After removing the cartilage Fairbank uses wire or kangaroo tendon to approximate the bones. I recommend a local autogenous bone graft packing the joint with chip grafts tucked around it.

Operations on the Elbow Region.—*Steindler's Elbow Flexor Plasty*—The object of Steindler's muscle plastic operation for the relief of flail elbow is to impart active flexion to the elbow joint by transplanting upward the origin of the flexors of the wrist so as to enable them to act as flexors of the elbow. The technic is as follows:

An incision is started 3 inches above the internal epicondyle of the humerus between the inner border of the brachialis anticus and triceps muscles. It is carried downward to the epicondyle and continued from this point obliquely downward and outward over the anterior aspect of the forearm. The ulnar nerve is retracted backward the common origin of the pronator teres flexor carpi radialis palmaris longus and flexor carpi ulnaris muscles with their periosteal attachments are carefully dissected off the internal condyle. One must be careful not to injure the nerve supply which reaches these muscles from below. Two inches of the muscle mass may be safely liberated. After the muscle layer has been dissected off its insertion it is carefully freed for 2 or 3 inches downward care being taken not to injure the median nerve which lies between the two heads of the pronator teres.

The inner surface of the humerus is then approached by blunt dissection through the intermuscular septum between the brachialis anticus and triceps muscles. The periosteal covering of the humerus is split longitudinally. The entire musculo-periosteal mass is then pulled upward for a distance of $1\frac{1}{2}$ or 2 inches and by periosteal sutures firmly secured to the denuded humerus while the elbow is held in acute flexion. The fasciae are then sutured and the skin closed.

Acute flexion of the elbow is maintained in plaster for two months. After two or three weeks the cast may be replaced by a splint so that massage and exercises may be begun. The best results are obtained where this method is combined with arthrodesis of the shoulder. Some power of the flexor muscles is essential to the success of the operation.

Arthrodesis of the Elbow — Arthrodesis of the elbow is a standard operation for flail elbow. It consists in denuding the articular surfaces of the ulna and humerus after which the raw bony surfaces are approximated with the elbow at an angle of about 90 degrees.

Operation on the Forearm — The Tubby operation is performed for the relief of pronation contracture of the forearm. It consists in transplantation of the insertion of the pronator radii teres. Gaenslen uses the biceps for a pronator and attaches it posteriorly and not laterally as Tubby does. Kreuscher has modified the Tubby operation. The pronator quadratus muscle may have to be divided in order to correct pronation deformity. A pronation contracture is more favorable than a supination contracture.

Operations on the Wrist Region — The operations performed on the wrist are manipulation, tendon transplantations and arthrodesis. The first is usually performed for palmar flexion deformity. After forcible manipulation the wrist hand and forearm are put in a splint so that active movements may be started and massage given.

Tendon transplantations around the wrist include substitution of the flexors to perform the functions of the extensors. Arthrodesis of the wrist is performed in cases of flail wrist. Through a dorsal incision the tendons are retracted the articular surface of the radius and the two carpal bones with which it articulates are denuded. The denuded surfaces are

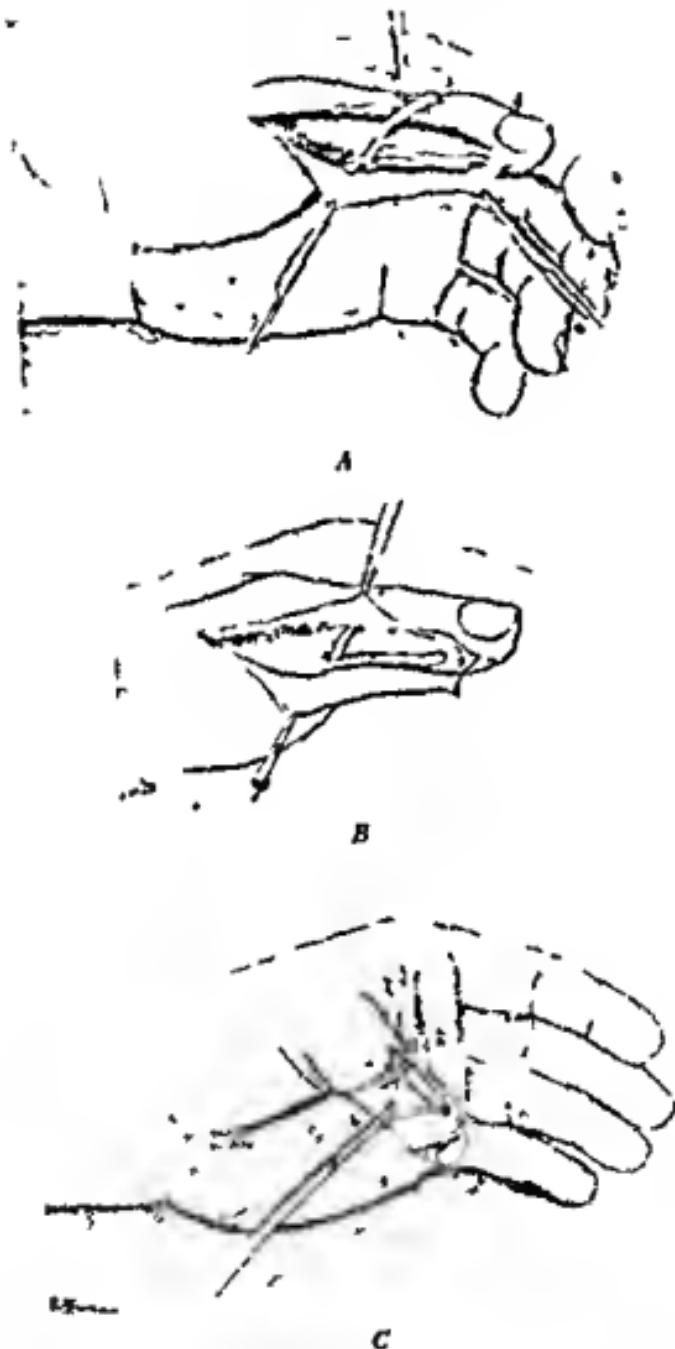
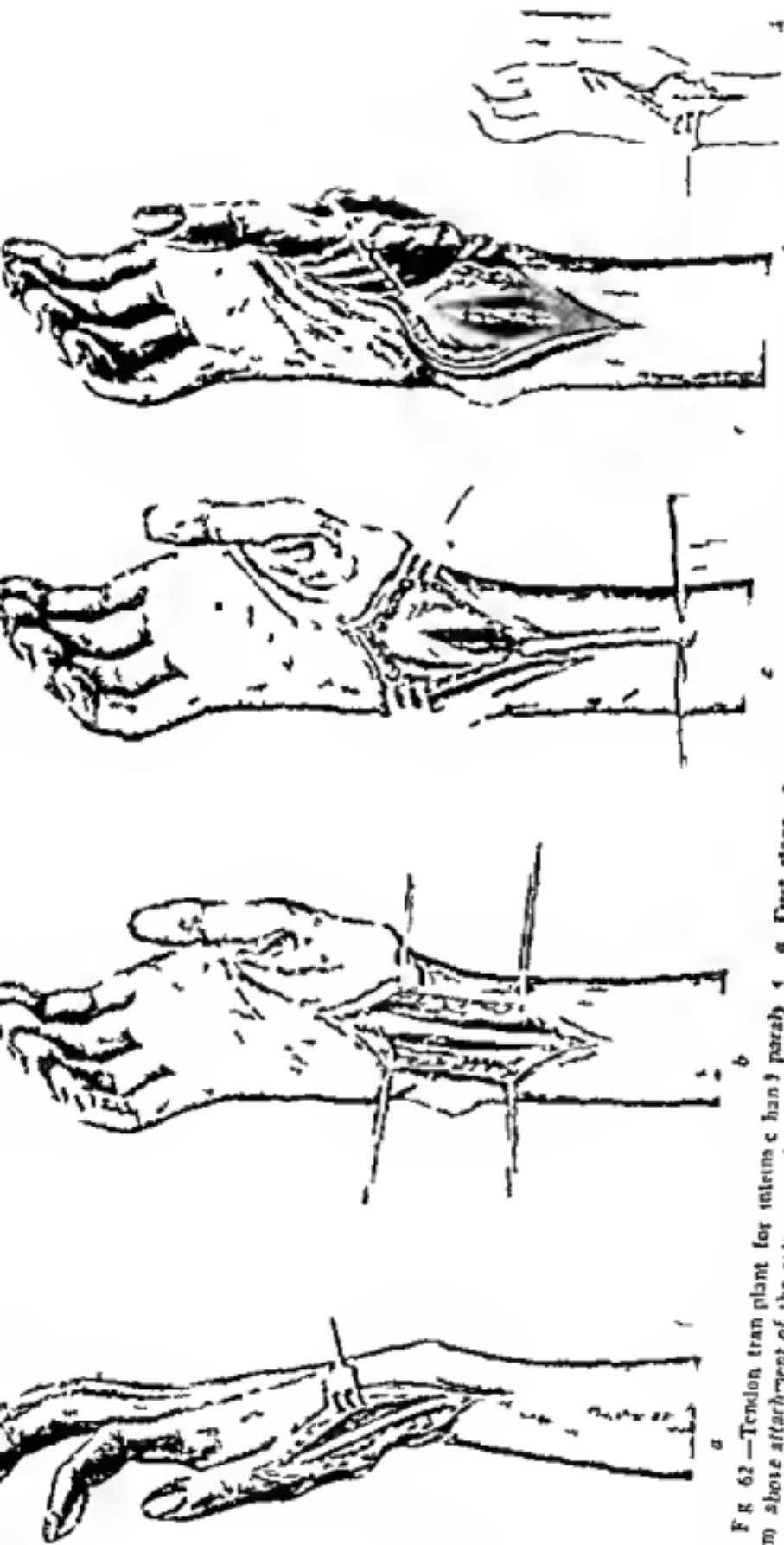


Fig. 61.—Flexor plasty of thumb. Thenar palsy. *A*, Thenar plasty. Freeing of the radial flap of the flexor pollicis longus. *B*, Tendon sheath reconstructed over remaining ulnar half of flexor pollicis longus. Radial half tunneled around the back of the phalangeal joint. *C*, Fixation of the radial flap into periosteum. Tension properly obtained with full flexion of thumb in all joints (Stendler). Note. The direction of the transplanted tendon should be more oblique.



3 cm above attachment of the anterior osseous metacarpal poll cis metacarpal poll cis b. Exposure of the palmaris longus tendon as it passes along the anterior annular ligament tangentially over the flexor tendons and the prehensile tendons and the extensor tendons of the fingers. The extensor tendons are shown to be attached to the metacarpal poll cis.

opposed and the wrist fixed in a position of moderate dorsiflexion. Some surgeons employ a bone graft.

Fusion of the scaphoid and semilunar to the radius abolishes wrist flexion and ulnar abduction.

Operations on the Hand—Operations on the hand are tendon transplantations and arthrodesis. Coordination of the thumb and index finger is the most important function of the hand. Therefore most of the hand operations are aimed at restoring the prehensile function.

For stiff metacarpophalangeal joints Steindler removes the head of the metacarpal while Ryerson removes the proximal portion of the phalanx.

Steindler's Thumb Check Operation.—This case fulfills Steindler's indications because he has weakness of the extensor tendons of his thumb but he has good function of the flexors. An incision will be made on the dorsum of the hand over the tendon of the extensor indicis proprius from the wrist down to the basal phalanx of the index finger. This tendon will be divided just beyond the base of the basal phalanx. A second incision will then be made over the tendon of the extensor pollicis longus reaching from the middle of the snuff box distally to the middle of the basal phalanx of the thumb. The tendon of the index finger will be grasped by forceps drawn through the tunnel between the radial incision and that over the index finger and led out through the incision at the thumb so that it will lie alongside the tendon of the extensor pollicis longus. Both tendons will be thoroughly sacrificed for a distance.

Dangle Arm.—In Steindler's 156 operations on the upper extremity the procedures included arthrodesis of the shoulder, flexor plasty at the elbow, tendon transplantations of the wrist and thumb regions, arthrodeses of the wrist and plastic operations on the joints of the hand.

Operations on the Spine.—The most valuable spine operation is the technic of Hibbs

all.—Lowman notes a specific relationship between paralysis of abdominal muscles and scoliosis. He performs an operation using fascia lata which is secured by an osteoperiosteal attachment to ribs, muscles or the pubes. He uses a strap of fascia 2 inches wide to reproduce the external oblique muscle.

In 1931 he opened the midline from a point above the umbilicus to the symphysis pubis. Lateral dissection uncovered the rectus aponeurosis on the right side. This was opened and reflected. A strap of fascia lata was transplanted extending from the lower 2 inches of the healthy upper rectus to the symphysis into which it was inserted through an osteoperiosteal gutter. The strap 1 inch wide and 9 inches long was sutured with silk above for 2 inches, then with the operating table dipped in the middle to slacken the pull on the abdominal wall, the umbilical stem was grasped with strong

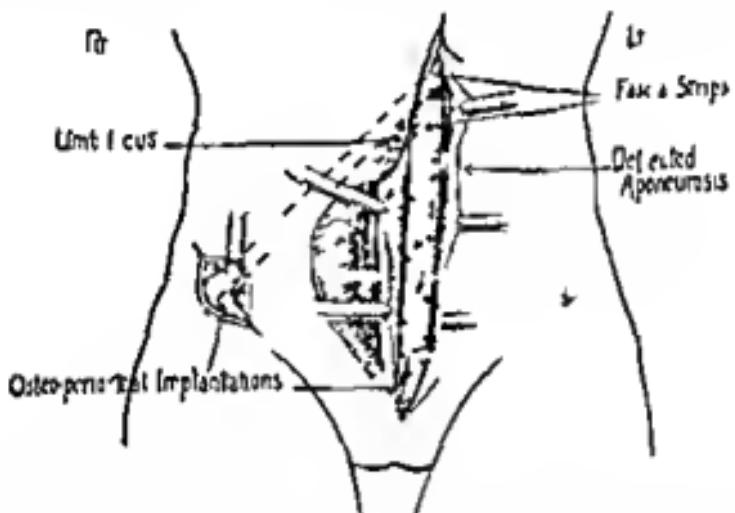


Fig. 63.—Lowman operation for abdominal muscle paralysis. One fascial strip has been inserted from the umbilicus to the symphysis; another from the umbilicus to the anterior superior spine.

forceps and pulled downward as far as possible while the lower end of the strap was forced into the osteoperiosteal slot below and firmly sutured with silk. Sutures of silk were similarly placed on each side at intervals of 1 to $1\frac{1}{4}$ inches. Then the aponeurosis was laid back and stitched down with chromic catgut. Before closing above another strap was fastened to the same location above and passed subcutaneously in the fat, downward and outward to the right ilium at the point of attachment of Poupart's ligament and attached periosteally as before, after all the slack was taken up which would be allowed by the shortened upper left oblique (Fig. 63).

Operations on the Pelvis and Lower Extremity—

Operations on the Pelvis—In discussing fixed pelvic obliquity Mayer calls attention to five types of contractures

He described a type of paralytic abduction deformity of the hip and an operation to correct same. He uses a band of the fascia lata which is drawn upward and inward and attached to the spine of the pubis by strong chromic sutures. This is done after he has removed the various factors causing the abduction contractures. A strip of fascia 2 inches wide and 8 inches long attached above by a broad pedicle is then drawn upward and inward through a subcutaneous channel and fastened under tension to the spine of the pubis.

Operations on the Hip Region—The chief indications for operation around the hip are flexion deformity, paralytic dislocation and paralysis of the abductors. The chief flexors of the hip, the iliopsoas, sartorius, tensor fasciae femoris and rectus femoris are involved much less extensively than the gluteus maximus. The hamstrings cease to function as extensors of the hip because the knee is usually in a fixed flexion contracture. The knee flexion makes a strong hip flexor out of the rectus femoris hence whatever strength there is in the flexors is almost unopposed. The rectus femoris when allowed to contract with the hip and knee flexed forms one of the greatest obstacles to extension of the hip. Mitchell has shown that with the hip flexed the power of the gluteus medius reinforced by the active sartorius and tensor fasciae femoris is sufficient to overcome the action of the weakened adductors.

Hip Flexion Deformity—The usual deformity is due to flexion and abduction. Hip flexion deformity is a condition that should be carefully guarded against. It is often overlooked and is the cause of many peculiar gaits. Because of the incomplete extension the patient makes a short step on the unaffected side, longer steps on the affected side and has a twist of the pelvis.

The structures most actively holding the thigh in flexion are the rectus femoris, the sartorius and tensor fasciae femoris, gluteus medius, iliopsoas and the capsule of the hip joint. The muscles which produce abduction are the glutei medius and minimus, the sartorius and tensor fasciae femoris.

When bilateral hip contractures exceed 45 degrees the quadruped position must be assumed

The principal methods of treating flexion deformity are Souter's operation, Campbell's operation and the method advised by Dunn.

Operations on the Foot—The foot is adapted for support and locomotion. The most important movement in propulsion of the body is controlled flexion and extension at the ankle. This movement can be retained by sacrificing the midtarsal and subastragalar joints. Bony union of these insures stability of the foot leaving such muscle power as is present for control of the ankle movements.

The patient with a bad paralytic foot deformity walks worse than a patient with an artificial limb. Motion between the foot and leg is a compound movement in the ankle, subastragalar and astragalo-scapoid joints. For good function it is necessary to retain some ankle joint motion. For architec-tural reasons it is necessary to retain intact the articulation at bearing points between the astragalus, tibia and fibula. It is necessary to stabilize the subastragalar and the astragalo-scapoid joints.

The objects of operation are (1) to correct deformity (2) to shorten the foot by removal of bone at the midtarsus (3) to increase the stability of the foot (4) to improve the balance and control of the foot. The movement at the ankle joint is retained for ease in locomotion.

Hoke offers the following qualifications of a foot after an operation:

1 It must look natural in shoes

2 It must be so stable that it will not turn laterally on the long axis of the foot when the patient is standing and walking

3 It must be so stable in a natural or nearly natural

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two lateral cuts one on each side one above and one below and then forcibly stretching the Achilles tendon so as to produce a lengthening (2) by open operation a linear slit down the middle of the tendon parallel with its long axis and a transverse slit above on one side and below on the other lengthening and then sliding the two portions over each other to the desired point and suturing the cut surfaces

The Sporon Hibbs operation is a double L lengthening that is one L within an L

A slight degree of shortening of the tendo achillis has advantages in cases of quadriceps insufficiency when weight is borne on the limb the strain on the gastrocnemius muscle locks the knee joint and so increases its stability In cases of simple cavus deformity the shortened tendon acts as an anchor which allows true correction of deformity by wrenching

Shortening operations on the Achilles tendon are not generally advised The simplest method of shortening is to make a steplike plastic operation removing the desired amount If the tendon is incised in its long axis and sutured transversely it will effectively shorten it

The chief operation on the ankle joint itself is arthrodesis In 1878 Albert curetted the joint surfaces of the astragalus and tibia and fixed the foot at a right angle Arthrodesis of the ankle joint is performed by denuding the lower end of the articular surface of the tibia fibula and astragalus of cartilage by placing these bones in apposition and maintaining them in a plaster of paris cast

Panastragalar Arthrodesis —Panastragalar arthrodesis means fusion of all the articular surfaces of the astragalus It was described independently by Goldthwait Albee and Steindler

The operation is recommended in cases of flail ankle joint a dangle foot with weakness of the quadriceps extensor When the operation is performed and the foot displaced forward and in slight equinus it helps lock the knee joint as the patient walks

The indications are a flail foot not deformed and the presence of a good knee or at least fair knee flexors

Morrison and MacKenzie recommend two osteoperiosteal grafts applied to the back of the foot and lower leg and sutured to the denuded periosteum of these structures Cramer

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- 1 It must look natural in shoes
- 2 It must be so stable that it will not turn laterally on the long axis of the foot when the patient is standing and walking
- 3 It must be so stable in a natural or nearly natural position

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clude those on the ankle and those on the Achilles tendon. *Achilles Tendon*—The chief operations on the Achilles tendon are lengthening and shortening procedures. Lengthening is performed by some type of plastic procedure

The operations for lengthening the Achilles tendon are (1)

lower end of the tibia and fibula anterior to the normal positions, so that on the inner border, the tibia articulates with the scaphoid and on the outer border the fibula rests on the cuboid. Originally the operation included the transplantation of the peroneals into the Achilles tendon to strengthen the calf group but this is not always done. Astragalectomy should be performed only on older children and in selected cases.

Putti's operation consists in driving a wedge shaped piece of bone transversely into the astragalus anteriorly so as to produce an anterior bone block.

The Whitman loop operation was designed for the correction of paralytic equinovarus in a foot in which all the muscles about the ankle, except one or both of the tibials, are strongly active. The loop operation consists of the following steps: (1) the displacement of the dorsal flexor tendons to the inner side of the foot. The displacement is assured by looping the distal part of the tendon of the tibialis anticus about the dorsal flexors and implanting it into the tibia. (2) transplantation of the peroneus brevis to the inner side of the foot preferably through the sheath of the tibialis anticus whose function it is to perform

used a perosteal bone flap on the anterior surface of the tibia, bridging the ankle joint

Campbell Drop Foot Operation.—To prevent drop foot Campbell erects a bony block behind the astragalus. This is made of many pieces of bone piled up above the posterior surface of the os calcis so that when the foot attempts to drop too far in equinus the block impinges against the posterior surface of the tibia

Coll's Operation.—With the foot in extreme dorsiflexion a osteotome which he drives from the os calcis just anterior to the attachment of the Achilles tendon. The bone wedge is tapped in place with an instrument, the wound closed and the foot put up in slight dorsiflexion

Brewster produces an arthrodesis at the astragalo calcaneal joint by means of a bone block made by trimming the astragulus and countersinking it into the os calcis. It prevents rocking of the foot in any direction and eliminates the necessity of doing a bone block of the posterior portion of the joint in cases of drop foot

Lambrinudi performs a step operation on the astragalus scaphoid and os calcis. The addition of tendon transplants enhances the value of stabilizing operations

For *paralytic equinus* deformity of the foot Miltner recommended making a longitudinal cut in the fibula in its lower one fourth and displacing the lower end of the posterior fragment of the fibula so that it acts as a block to prevent the equinus position of the os calcis. Arthrodesis of the tarsus and tenotomy of the tendo achillis may accompany this procedure

Calcaneus.—The operations for calcaneus are chiefly the astragalectomy of Whitman and modifications of the sub astragalar arthrodesis. Putti designed an anterior block which is analogous to Campbell's posterior block. Campbell designed an osteotomy of the os calcis. Subcutaneous plantar fasciotomy may be performed in addition

In the astragalectomy of Whitman the astragalus is removed through a lateral incision the foot is displaced backward on the tibia and fibula and a new bed is made for the

lower end of the tibia and fibula anterior to the normal positions, so that on the inner border, the tibia articulates with the scaphoid and on the outer border, the fibula rests on the cuboid. Originally the operation included the transplantation of the peroneals into the Achilles tendon to strengthen the calf group, but this is not always done. Astragalectomy should be performed only on older children and in selected cases.

Putti's operation consists in driving a wedge shaped piece of bone transversely into the astragalus anteriorly so as to produce an anterior bone block.

The Whitman loop operation was designed for the correction of paralytic equinovalgus in a foot in which all the muscles about the ankle, except one or both of the tibials, are strongly active. The loop operation consists of the following steps: (1) the displacement of the dorsal flexor tendons to the inner side of the foot. The displacement is assured by looping the distal part of the tendon of the tibialis anticus about the dorsal flexors and implanting it into the tibia. (2) transplantation of the peroneus brevis to the inner side of the foot preferably through the sheath of the tibialis anticus whose function it is to perform



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SCOLIOSIS

Scoliosis is defined as a deformity of the spinal column in the frontal plane. This term was coined by Hippocrates. The term was indiscriminately applied to all deformities in his time. This is done by a few today.

There are many classifications, the most practical clinically is that of Schulthess.

- 1 Primary form deviation, congenital scoliosis
- 2 Secondary form deviation due to changes outside of the spine
 - (a) Secondary to diseases of nervous system—paralytic, hysterical, neuritic, spastic, sciatic scoliosis
 - (b) Secondary to diseases of internal organs—respiratory disturbances emphysema pleurisy
 - (c) Scoliotic attitudes from circulatory lesions
- 3 Scoliosis from diseases and acquired anomalies
 - (a) Constitutional debility or insufficiency, habitual or idiopathic scoliosis
 - (b) Rachitic
 - (c) Scoliosis in diseases as osteomalacia, neoplasms, arthritus or in injuries

According to location there is the left total, the dorsal, the lumbar, the lumbodorsal and cervicodorsal. Left total and right dorsal curves are said to be most common. Our group¹ presented one left total and four right total curves. Three fourths of the cases were right dorsal primary curves. One fifth were left dorsals. There were three lumbodorsal and one cervicodorsal. Three fourths of the cases were females.

¹ From the clinic of Henry Bascom Thomas, M.D. Professor of Orthopedic Surgery University of Illinois College of Medicine Research and Educational Hospital Surgical Institute for Children St. Luke's Hospital Chicago

Carey and others have noticed that 25 per cent of the school children are undernourished. They have found degenerated muscle cells in autopsy specimens of children dying of debilitating and infectious diseases, and maintain that scoliosis is a spinal sign of muscle and bone imbalance of the back and is not a specific disease entity. Steindler develops this thought nicely in his discussion of pathogenesis beginning with the disproportion of weight bearing theory of Shanz, through the altitudinal theory of Meyer, Lovett, Abbott, etc., into the rachitic theory of Schede.

Whatever these factors that cause the curvature may be, they are present and exerting their influence on the spine long before a fixed deformity appears. Steindler calls this stage the prescoliosis stage. He defines it as 'a clinical period of absolute latency when the pathogenic conditions such as congenital malformations, rickets, habitual posture, etc., are present, but when, as yet, no unmistakable sign of scoliosis has appeared.' Recognition of this stage is most important as it is during this stage, and not in the beginning stages of scoliosis itself, that the most effective work of scoliosis prophylaxis can be accomplished. This stage ends when it becomes more and more difficult to arouse the child out of an asymmetrical attitude. He is then a scoliotic.

Scoliosis develops according to certain principles. A simple rod cannot be bent without some associated twisting or rotation. Neither does the spine bend without rotation. Lovett has noted that in side bending the bodies rotate toward the convexity. The spine does not depend upon muscles for stability. A spine with all its muscles removed remains quite rigid. In a paralytic scoliosis the convexity of the primary curve points toward the paralyzed muscles if it is the long muscles that are paralyzed, while paralysis of the transverse, traction or torsion muscles is accompanied with a convexity toward the well muscle side. This latter type is also associated with severe rotation. Spines which have strong or intact ligaments seem to lean over and are known as an inclination type of scoliosis as in an early paralytic scoliosis. Spines in which the ligamentous apparatus is relaxed as in rickets, the bodies seem to slide off each other or collapse.

The recording of the status of a case of scoliosis may be

A little better than one third of our cases applied for treatment after fifteen years of age. Another third applied between the ages of twelve and fifteen. Only one fifth applied before the age of eleven, the majority of these being ten or eleven years of age. The curves were incidentally found by the dressmaker, gym teacher or noticed after an accident. Only 1 patient (congenital) applied before the second bulge in growth rate.



Fig. 64.—A congenital scoliosis case in a girl (aged eleven) showing many anomalies in the dorsal region—improved and held by exercises. Marked curve at age of four years when treatment was begun. The seventh cervical is almost plumb with the sacrum.

The cause of scoliosis is a mooted question. In the congenital group however it is plainly evident. One or more of the bodies have a change in shape from slight distortion to wedge formation. In the rachitic the curvature develops because of softness or laxness of the ligamentous and osseous structures. In the habitual the causative factor is not so evident. Hibbs maintained that they were due to an unrecognized anterior poliomyelitis. Mark Jensen would have one believe that the difference in level of the insertion of the crura of the diaphragm has something to do with it.



Fig. 67.—The ladder and other gymnasium equipment can be used for passive as well as active exercises



Fig. 68.—The shift exercise. A right dorsal curve. The crest of the ilium is firmly grasped with the hands the trunk stretched and shoulders abated to the left. This position is held and the hands relaxed. A good exercise for reeducating a new sense of balance

done in various ways x Ray films are perhaps the most accurate. They should be made with a long cassette with the patient standing at a uniform distance from the tube. This technic must be the same for all pictures of the same individual. The improvement or progress of the curve may be measured in degrees according to the technic of the Hibbs Clinic or else compare the curves by superimposing one film over the other. Taking photographs with the patient a specified distance from the camera behind a marked screen or plumb line is acceptable but not considered as accurate.

A pair of twin scales is quite convenient in keeping a note of the distribution of body weight. If one believes as Whitman



Fig. 65



Fig. 66

Fig. 65—The Klapp exercise. The reach of arm and leg must be to the limit. The photo is inaccurate as the arm and leg on same side are in extension. The extreme reach stretches and loosens the spine. Knee pads and mittens of felt make the creeping more comfortable.

Fig. 66—The plynth used for passive as well as active exercises.

states that treating the mind is as essential as treating the curvature this is a good piece of apparatus to use in convincing the patient that his posture is wrong.

All forms of treatment in vogue today embody the principles of mobilization, correction and fixation. Hosta was the first to bring them out and insist on a proper balance between the three. To an impartial observer it will be clear that no good can be accomplished if a spine is loosened or mobilized quicker than the muscles can be strengthened or if a spine is immobilized in plaster corrected and allowed to go without strengthening the muscles.

The mobilizing exercises consist of general exercises as one

of the two sides becomes equal, then both sides must be exercised equally. The range of motion of the spine must be made equal on both sides, etc.

The exercises should be under the supervision of an instructor, as the parents and patient are too careless. The author cannot recall of any patient improving by doing the exercises at home.

Correction is accomplished by one of two methods. The turnbuckle casts or extension. The latter method, described by Kleinberg, consists of putting the patient on a curved Bradford frame with head pelvic traction and lateral traction applied to the convexities of the curves.

A more certain method of correction is found in the so called "turnbuckle casts" as described by Risser. The Lovett jacket works quite similarly.

The patient stands in an upright traction frame in a Glisson sling with just enough traction to steady the head, the leg on the concave side of the primary curve is abducted 20 degrees, the leg on the convex side is put on a 2 inch block. This will . . .

the other, at the same time shifting the upper trunk toward the high arm side. A plaster cast is now applied to include the abducted thigh, body neck and out toward the high elbow. As the plaster sets, this shift that the patient has initiated is increased and the shoulders rotated into the same plane as the pelvis. Correction is further increased by cutting the cast transversely opposite the apex of the primary curve, inserting a hinge in front and in back in the axis of the curve, plastering in a turnbuckle on the concave side and further screwing open the ends of the curvature as rapidly as the comfort of the patient allows. Casts are changed as often as conditions require.

Can a curve be corrected? On this point of the treatment there arise two schools. One maintains that a curve cannot only be completely corrected but overcorrected and the other maintains that it cannot be corrected. Only the ends straighten. On this point Steindler developed his treatment by compensation. His school takes the stand that a curve is

practices them in the army or school gym. The exercises should not be limited to trunk exercises but exercises for the extremities should be included. This immediately becomes apparent when one notices how thin the arms and legs of

Fig. 69



Fig. 70



Fig. 71



Fig. 72



Fig. 74



Fig. 75



Figs. 69-75—A group of mat exercises for limbering up the lumbar spine. The reach and accomplishment of each exercise must go to the limit.

many of these patients are. In fact some of the parents mention that as one of the symptoms in the condition. The accompanying photos illustrate the exercises well. Different authors stress different details. Lovett states that the weak side of the body should be exercised most until the strength

to the treatment. If this balance has been obtained with rigidly supervised exercises, but cannot be maintained alone maybe it can be held with the aid of a brace (whatever the type of brace worn it needs a leg extension in the majority of cases). If exercises do not loosen the spine enough to attain the above described state then add enough corrective treatment to attain that state. Having obtained it put the patient



Fig. 77

Fig. 78

Figs. 77-78.—Before and after fascial transplant from right anterior superior spine to the ninth and tenth ribs on the left side. Left ankle was also arthrodesed after lengthening of the tendo achillis.

in some type of removable cast or brace and add the exercises again. If correction can now be maintained until after the age of seventeen you have accomplished your aim. When such a patient is dressed it takes a keen layman to detect the deformity.

If, however, the compensated state cannot be maintained correct and instead of stopping with exercises this time go

rigid and cannot be corrected or at least that it is wiser not to correct it if it could be done

The principles of mobilization correction and fixation are used in their proper ratio just as by the other school. Instead of attempting to eliminate the curves he aims to develop the secondary curve to equal the primary curve. In other words



Fig. 76.—x Ray of a spine that was fused in compensation two years ago. Note the lines of force forming as the nearest straight line. Plumb line passes through the seventh cervical and the sacrum.

it is aimed to develop the balance of the patient to the extent of getting the seventh cervical spinous process to lie in the same plane with the spinous process of the sacrum and the pelvic shoulder planes to coincide. If such a case is put on a pair of twin scales he will nearly tip both scales the same

If exercises alone will accomplish this that is all there is

cysts opened further up but the patient is still paralyzed Steindler has found the acute angulation to be the cause of the paralysis mechanically Others, as Gold and Sternberg have found no cause at time of operation but at autopsy found an associated tuberculosis The tuberculosis cannot be recognized because of the deformity

The treatment of scoliosis then consists in carrying out three principles mobilization under careful supervision, correction, you may align yourself with the school of complete correctionists or compensationists, just so that you do not outstrip your immobilizing powers for a poor musculature surely can hold a spine with a rigid curve in balance easier than a lax spine which has had its rigidity taken from it by forceful methods of correction And finally if correction can not be held by the muscles consider the aid of a brace or fusion operation, bearing in mind that in the light of past experience the chances of your fusion holding are about 50 per cent Since most patients do not apply for treatment until after the deformity is fixed as three fourths of ours did should not more attention be given to the debilitated group of children watching for asymmetrical mannerisms before they become deformities?

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on through the fixation stage by fusing the curves and then go back to the exercises

How long do the exercises have to be kept up? One might say indefinitely. These muscles have an extra load to carry as the balance of the spine is not perfect. No matter which school of treatment is followed, the muscles have to be kept in proper tone to cope with the situation.

If the musculature is not able to maintain the balance some assistance is sought in operative fixation. This is accomplished by the technic of the Hibbs or Albee fusion operations or a combination of the two. After the fusion is healed the spine has to have the accessory support of the brace and the patient has his exercises to do just as he did before the operation. That this passive rigidity is beneficial is attested to by the patients that had the fusion. They note that they fatigue less easily and that it is easier for them to breathe. The fusion operations as done today are not the solution in the treatment of scoliosis. The operation fails to maintain the correction in a fairly high percentage of cases.

Recently another procedure has been used in conjunction with the fusion or independent of it—the so called fascial slings. The most common one is a strip of fascia taken from the thigh in conjunction with the tensor fasciae femoris muscle and passed obliquely upward in the subcutaneous tissues of the abdominal wall to the thoracic cage on the opposite side and anchored into the ribs. This may be done on one or both sides depending whether the abdominal muscle paralysis is single or bilateral. This operation has improved the stance of the patient shown in the picture but was not sufficient. This patient is being recorrected preparatory to a fusion.

Complications of scoliosis are not very frequent and of them paralysis is the most difficult to treat. One case in the

had a paraparesis whose sensory loss level was in

treatment now four

n onset not unlike a

polio, in fact what was at first a diagnosis. There was

no improvement with frame and traction treatment. An ex

ploratory was done by Dr Eric Oldberg our neurosurgeon

who found a gliomatous cyst. For a short time the patient

improved was up and walking for several months when she

had a relapse. Other explorations have been done, other

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BENIGN UTERINE BLEEDING

AMONG the common symptoms produced by the female genitalia, benign uterine bleeding stands high in the list. It may appear at any age from puberty to old age. Its causes are exceedingly varied. The diagnosis and treatment may be simple or may call for the utmost in skill and experience.

The subject can best be considered by a classification based on etiology. The following classification has been used:

ETIOLOGY OF BENIGN UTERINE BLEEDING

I. Constitutional

- (A) Endocrine (functional)
- (B) Circulatory diseases
- (C) Chronic infections
- (D) Blood dyscrasia
- (E) Hygiene

II. Local

- (A) Benign tumors of the uterus
- (B) Chronic inflammatory disease and malposition
- (C) Complications of pregnancy

From the standpoint of frequency another classification based on age periods may be utilized. Benign uterine bleeding occurs in four groups as follows: (1) adolescent, (2) childbearing, (3) menopausal, (4) postmenopausal. The sole value of this grouping is to emphasize the dominance of a particular cause during that age period, e.g., endocrine bleeding in adolescence, the bleeding of pregnancy in the childbearing period, the bleeding due to tumors as the menopause approaches, and bleeding due to cervical polyps and chronic

unculated fibroid. For such discrete masses the obvious procedure must be removal by torsion, or clamp and ligation, or a cutting and coagulating current, depending on the size and vascularity of the pedicle. The polypoid type of endometrium is usually discovered at the time of diagnostic curettage and will then justify a therapeutic curettage at the same sitting. It is generally believed that the basis of this abnormal proliferation of endometrium is an excessive production of follicular hormone.

Formerly treatment for functional bleeding consisted in repeated curettements. With the advent of radium this was employed in small dosages. In the most severe instances hysterectomy was performed. Today it is believed that functional bleeding is a result of a disturbance in the production or relationships of the gonadotropic hormones with a resultant imbalance in the biological action of the two ovarian hormones. The therapeutic approach therefore has been the use of either corpus luteum hormone products or, preferably, the anterior pituitary like products, the majority of which are derived commercially from the urine of pregnant women or mares, e.g., antuitrin S, A P L, follutein, and antophysin.

In the other 50 per cent of these patients with functional bleeding the endometrium is not characteristic, varying from the normal to various stages of secretory changes superimposed upon a cystic proliferative endometrium or a mixture of secretory and nonsecretory proliferation in the same endometrium. Here the evidence of hyperestrinism may not be demonstrable, but these patients may respond to the same endocrine therapy.

Another form of treatment for both of these large groups is the stimulation of the pituitary gland and ovaries by small dosages of roentgen ray. Care must be taken to avoid the risk of precipitating a premature menopause.

In urgent situations transfusions must be used and re-

Among these are sterility resulting from an inadvertent radium menopause, and infection which may end in tubal occlusion and sterility and occasionally in a fatality.

I CONSTITUTIONAL DISEASES

(1) Endocrine (Functional) Bleeding—For an understanding of this type of abnormal bleeding it is desirable to review what is accepted today as the normal physiology of menstruation. The anterior lobe of the pituitary is believed to be the pacemaker of menstrual rhythm which stimulates ovarian activity by the production of gonadotropic hormones. These are two biologically different principles designated as prolactin A and prolactin B. The normal production of prolactin A results in the ripening of the Graafian follicle which, together with the degenerating primordial follicles, produce the follicular hormone which stimulates the repair and later the proliferation of the postmenstrual endometrium. At or about the middle of the cycle the Graafian follicle

developmen

ization of

occurs under the influence of the prolactin B fraction of the anterior pituitary gonadotropic hormone. This causes the elaboration of a progestational hormone from the corpus luteum. Under the influence of the corpus luteum hormone secretory changes ensue in the endometrium and the cells of the stroma assume the appearance of decidual cells. If the anticipated pregnancy does not occur the corpus luteum undergoes degeneration, its hormone no longer maintains the integrity of the secretory endometrium and the capillaries of the endometrium which like all the capillaries of the body are fragile at this time release their vascular content and menstruation occurs carrying with it the superficial layers of the endometrium.

The commonest of the functional types of bleeding occurs in women otherwise normal in whom menstruation is prolonged and excessive with varying degrees of irregularity. In approximately 50 per cent of these patients uterine scrapings

1. Intrauterine type of endometrium. In the most

endometrium (cystic pro-

go on to the formation of

lyps. These may vary in

size from many small (0.3 to 1 cm) polyps to a single polyp which may present at the external os measuring 2 to 3 cm in long axis and of a consistency which may simulate a ped

venous stasis. The veins of the broad ligaments are numerous and capable of marked engorgement even in the nullipara. In older women who have borne children this is frequently striking and demonstrable at laparotomy. In fact these engorgements may be responsible for the dragging dull pain in the pelvis for which there is no other detectable explanation. It is easy to understand that the constant venous engorgement of the uterine circulation which parallels broad ligament venous engorgement may result in alterations in the normal menstrual flow. Prolonged menstruation and slight intermenstrual bleeding following unusual exertion is one of the symptoms which may appear in these women who have variable degrees of cardiac decompensation. Appropriate medication may be sufficient adequate rest and a permanent readjustment of the individual's activities is more important. There is no local treatment.

In older women uterine bleeding may occur without any demonstrable local pathology. Uterine scrapings are not significant. In such instances vaginal hysterectomy has revealed an organ in which there is definite arteriosclerosis. This is usually accompanied by generalized arteriosclerosis but not necessarily. Mild hypertension may likewise be present but is not an outstanding feature. In the treatment of these patients we must attempt to satisfy ourselves by microscopic examination of uterine scrapings that we are not dealing with a carcinoma of the corpus uteri. Assuming that the scrapings show no evidence of malignancy the choice of treatment then lies between irradiation with radium and vaginal hysterectomy. The patient is usually in the fourth or fifth decade of life. Permanent loss of menstruation is harmless and perhaps desirable. If the uterus grossly is apparently normal and the supporting structures of the pelvis are in good condition 50 mg of radium may be introduced at the time of the curette ment. Immediate frozen sections of the uterine scrapings with negative results permit us to carry out the radium insertion as part of the curettage procedure. Depending on the age of the woman 1800 to 2400 mg hours is usually sufficient to produce a permanent menopause with atrophy of the uterine vessels and cessation of the bleeding. If the uterus is heavy possibly in retrodisplacement with beginning descensus and

In recent years moccasin snake venom in therapeutic doses 0.5 cc to 1.0 cc has been successfully employed. Gradually in antivenom is built up within the patient and by a mechanism thus far unknown the capillary fragility is decreased and the bleeding is controlled.

Irradiation of the spleen insulin therapy vitamin C therapy have all been suggested and employed. The reports in the literature do not seem to us to justify their acceptance at present.

The next group in which functional bleeding occurs presents a picture of diminished thyroid efficiency. These patients show a lowered basal metabolic rate and in addition they present even to the expected to extract T₄. The elevation is not excessive for the markedly deficient hypothyroid type.

In view of the bleeding in cases it has been recommended for functional bleeding in women in whom there is no clinical nor metabolic evidence of hypothyroidism. I cannot approve of this recommendation as a substitute for those procedures which have proved their worth as outlined above.

It should be borne in mind that endocrine therapy is not entirely empirical nor entirely harmless. Those who use the many available preparations of various organs should have a clear concept of their purpose in relation to the patient's symptoms. For example prolonged and excessive dosage with follicle stimulating hormones have been shown to result in the development of polycystic ovaries. The treatment and the patient must be correlated and the reaction of the patient must be closely observed.

(B) Diseases of the Circulatory System—Valvular heart disease continues to be a common and often unrecognized ailment. The borderline between complete and incomplete compensation becomes obvious with the edema of tissue retention dyspnea and similar classical symptoms. Before this stage is reached there is usually a variable degree of

venous stasis. The veins of the broad ligaments are numerous and capable of marked engorgement even in the nullipara. In older women who have borne children this is frequently striking and demonstrable at laparotomy. In fact these engorgements may be responsible for the dragging dull pain in the pelvis for which there is no other detectable explanation. It is easy to understand that the constant venous engorgement of the uterine circulation which parallels broad ligament venous engorgement may result in alterations in the normal menstrual flow. Prolonged menstruation and slight intermenstrual bleeding following unusual exertion is one of the symptoms which may appear in these women who have variable degrees of cardiac decompensation. Appropriate medication may be sufficient adequate rest and a permanent readjustment of the individual's activities is more important. There is no local treatment.

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The next group in which functional bleeding occurs presents a picture of diminished thyroid efficiency. These patients show a lowered basal metabolic rate and in addition they present the usual clinical picture of hypothyroidism even to the degree of myxedema. These patients may be expected to respond to adequate controlled dosage of thyroid extract. Ten grains daily with the patient under close observation is not excessive for the markedly deficient hypothyroid type.

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rise to abnormal bleeding. Emotional disturbances, climatic changes, and nutritional changes resulting from protein deficiency can produce this condition. In the first two the history points to the diagnosis, and the treatment obviously would not be local. The nutritional disturbance is commonly accompanied by a hypochromic anemia. The chlorosis of former days which is so seldom seen now is an example. The administration of any form of iron and a correction of the dietary deficiency will establish a cure.

II LOCAL CAUSES

(A) Benign Uterine Tumors.—In women approaching the menopause fibroid tumors of the uterus are increasingly common and gradually become the outstanding cause of bleeding. The location of the fibromyoma or adenomyoma in relation to the uterine wall determines whether the tumor may produce bleeding. Subserous tumors whether pedunculated or sessile, single or multiple, large or small do not affect the normal menstrual cycle nor cause intermenstrual bleeding. Intramural tumors may or may not cause bleeding depending on their proximity to the endometrium. The submucous variety of fibroid is the outstanding group which produces abnormal bleeding as one of the symptoms of its presence. An occasional submucous fibroid is extruded by the musculature until it becomes pedunculated and finally appears at the external os. This type of tumor is almost invariably accompanied by abnormal bleeding.

The type of bleeding may be a prolongation of the normal menses (hypermenorrhea) beyond the maximum normal duration which is generally placed at three to four days of flow and three days of terminal spotting or an excessive blood loss (menorrhagia) usually with clotting and sometimes alarming in amount but within the time limits of a normal menses for that patient, a recurrence of normal or abnormal menstrual cycles at intervals closer than the normal for the individual (polymenorrhea) and finally bleeding at times other than the menstrual cycle (metrorrhagia). The source of this bleeding is almost invariably from the vessels of the endometrium. The latter owing to the presence of the adjacent tumor or tumors, undergoes changes in its structure usually atrophy.

there is a cystocele and/or a relaxed pelvic floor, then we prefer vaginal hysterectomy and plastic reconstruction. It is well known that curettage cannot be all inclusive and that an early corpus carcinoma may be overlooked despite curettage. Nevertheless, either of the above procedures while not ideal if the corpus carcinoma had been diagnosed in advance, may be relied upon to effect a cure.

(C) **Chronic Infections**—Tuberculosis one of the outstanding constitutional diseases, is regarded as a potential source of uterine bleeding. In the pulmonary variety associated with fever, sweats, and emaciation, it has been my experience that not only is there no intermenstrual bleeding but that these women have long periods of amenorrhea. Tuberculosis of the genitalia, on the other hand, may, as with any other pelvic inflammatory process, cause uterine bleeding. Tuberculous salpingitis is comparatively uncommon and is usually diagnosed at operation. In the patient who presents the classical symptoms of pulmonary tuberculosis and in whom there is uterine bleeding the latter symptom must be regarded as unrelated and the explanation sought for apart from the pulmonary lesion.

Syphilis, like tuberculosis, attacks most of the systems of the body, unlike tuberculosis it has rarely been described as a cause of uterine bleeding. Gellhorn has pointed out that amenorrhea of unexplained origin accompanied by positive Wassermann reactions specific antisyphilitic therapy has caused cessation of the abnormal bleeding. This conforms with the experience and practice of the past generation of physicians who when confronted with ailments which did not respond to direct treatment had recourse to potassium iodide mixtures.

(D) **Blood Dyscrasias**—Thrombocytopenic purpura one of the rare diseases may present in addition to the usual extravasations, bleeding from the uterus. The diagnosis is based on the decreased platelet count increased bleeding time and clinical manifestations. The best available treatment is repeated blood transfusions. In the more severe instances of

cision. Pregnancy should not be attempted by such women until half a year after the myomectomy. They must likewise be told that retention of the uterus in the hope of offspring carries with it the risk that in subsequent years other fibroid tumors may make their appearance and require subsequent hysterectomy. It is further desirable that before such conservative surgery is undertaken fertility of the marital partner should be established. The possibility of subsequent fertile partners may be mentioned but rarely becomes a matter of practical bearing. If the patient is in the younger years has no hope of offspring but desires to retain her menstrual function then myomectomy may be combined with defunction. When chronic infection of the endocervix is present and we contemplate a myomectomy we prefer to cure the infection before undertaking the operation. The electrocautery is our usual choice for this purpose.

Pedunculated submucous fibroids are always associated with infection of the pedicle and endometrium. If there is no other fibroid tumor present then the pedunculated submucous tumor may be removed by clamp and ligation of the pedicle or by the use of cutting and coagulating current. When there are other tumors of the uterus it is a grave error to remove these by supravaginal hysterectomy at the same time that one removes the pedunculated submucous tumor. Infection is almost certain to follow. The pedunculated submucous fibroid must be removed first and the hysterectomy whether abdominal or vaginal postponed for six to twelve weeks.

Occasionally we find a fibroid of considerable size in the wall of the portio vaginalis of the cervix which causes bleeding. The simplicity with which such a fibroid may be shelled out from its pocket vaginally has led to many a fatality from sepsis. Such cervices are always infected and their rich lymphatic circulation renders the spread of infection easy.

Before any of the above operative procedures is undertaken the physical condition of the patient must be brought to the best possible level. Women who have bled over long periods of time may not show the evidences of blood loss by pallor or even in the blood count but it may be taken for granted that their blood making organs have been unduly taxed and that their resistance is below par. We consider

These changes disturb the normal physiology of the endometrium. Occasionally bleeding may result from rupture of a small varix on the surface of the submucous tumor.

Diagnosis of submucous uterine tumors is comparatively simple in a woman who has multiple fibroids, and who presents a history of one or another of the types of abnormal bleeding just outlined. The difficulty of the diagnosis increases when the corpus uteri is only slightly enlarged, if at all and on bimanual examination shows no discrete area of altered consistency. The skilled operator can usually with the aid of a blunt curet locate an irregularity of the surface of the corpus cavity which will confirm his suspicion of the presence of a submucous fibroid. An x-ray picture of the corpus cavity outlined by means of lipiodol injection is more satisfactory and a simpler procedure. It requires lateral as well as antero-posterior views. This should not be carried out when the patient is bleeding.

The early treatment of fibroids of the uterus was solely a choice between hysterectomy either abdominal or vaginal and prolonged administration of ergot. The gynecologists of a generation ago did not have any form of irradiation available and were loath to perform myomectomy, single or multiple excepting for the simple pedunculated subserous type of tumor. The modern gynecologist has a much wider range of choice. These patients fall into two general groups those who are still in the childbearing years and who wish to have fertility preserved and those who are approaching or past the menopause. In the former group if the patient is in good condition and the uterus and cervix show no evidences of active infection it is imperative that she be told that the uterus can be preserved. Single and multiple fibroid tumors in all locations and of all sizes can be dissected out of the uterine wall the pockets properly sutured and the uterus retained for child bearing.

This may be done regardless of their encroachment on the corpus cavity. The general procedure is to make multiple incisions for tumors remotely separated. Bonney who has had a very large experience with this conservative type of gynecology, prefers to shell out fibroids in practically all locations through a single anterior wall or transverse fundal in

cision. Pregnancy should not be attempted by such women until half a year after the myomectomy. They must likewise be told that retention of the uterus in the hope of offspring carries with it the risk that in subsequent years other fibroid tumors may make their appearance and require subsequent hysterectomy. It is further desirable that before such conservative surgery is undertaken fertility of the marital partner should be established. The possibility of subsequent fertile partners may be mentioned but rarely becomes a matter of practical bearing. If the patient is in the younger years has no hope of offspring but desires to retain her menstrual function then myomectomy may be combined with defundation. When chronic infection of the endocervix is present and we contemplate a myomectomy we prefer to cure the infection before undertaking the operation. The electrocautery is our usual choice for this purpose.

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disturb the normal menstrual mechanism. As a result, these women display any or all of the types of bleeding previously described, *i. e.*, menorrhagia, hypermenorrhea, polymenorrhea or metrorrhagia.

It is desirable to have a bacterial diagnosis when possible. The unmixed gonorrhreal infection, if treated conservatively, lends itself very well to a complete cure without operation. The mixed infections are more destructive and more often will eventually require some operative procedure. Bleeding in such patients is best controlled by the same treatment which is most beneficial for the underlying infection, namely, rest. The more acute the process the more prolonged the rest must be. When the patient has achieved a degree of immunization and the status may be classed as a chronic infection, then that treatment must be selected which is appropriate to the residual pathology. A simple endocervicitis can be cured with the electrocautery, whereas chronic pus tubes which do not yield to diathermy, prolonged hot vaginal irrigation, and other conservative measures, must be removed. We prefer to combine defundation of the uterus with bilateral salpingo-ovarectomy in order to remove permanently a potential source of further bleeding or infection. I have given up the use of ovarian transplants in those instances in which ovarectomy was done for chronic inflammatory disease. The transplant may harbor organisms which though latent in their original site give rise to infection and sloughing when implanted. Moreover the life of the implant under the most favorable of conditions does not exceed two years. It is comparatively simple with the preparations available to us now to maintain the patient in comfort after an operative menopause.

Fibrosis uteri is a term commonly applied to the uterus from which there is bleeding without gross detectable pathology in women toward the end of the childbearing period. Such uteri have usually been the seat of a low grade, long standing inflammation of the endometrium with deposition of connective tissue through the stratum spongiosum and invasion of the adjacent myometrium. Bleeding from such uteri is readily controlled by radium 1800 mg hours being adequate. If there is associated injury to the superior fascial plane and supporting structures of the pelvic floor, then a vaginal hysterectomy and plastic reconstruction is, of course, preferable.

transfusion, single of 500 cc or repeated at three day intervals as indicated, to be valuable insurance prior to operation.

For the women who are through childbearing or who are menopausal or postmenopausal, hysterectomy is the procedure we elect. We have gone through the period of irradiation therapy for bleeding fibroid uterus. At first radium was used even when the organ and contained tumors were double fist sized or larger. Gradually as the untoward effects of radium became manifest, such as recurrence of the bleeding febrile reactions, late bladder symptoms and even rectal irritation, we limited the use of radium more and more until now we have practically abandoned its use for women in whom there is bleeding due to even a single submucous fibroid. Vaginal hysterectomy for those patients in whom the uterine mass is not too large, freely movable, and unassociated with adnexal disease, is so simple, carries so low a mortality, and is followed by so uneventful a postoperative course that it has become our choice for this group. For the occasional patient in whom there are medical contraindications to any type of operation or who refuses surgery we prefer deep roentgen ray therapy.

Not infrequently a cervical polyp causes uterine bleeding both in younger women and even in the late postmenopausal years. Unhappily too many such patients have been treated subjectively with never a speculum examination. The history is often almost pathognomonic since the bleeding so frequently follows coitus. Visualization of the cervix is imperative. When a polyp is revealed simple avulsion is usually a cure. However, we consider that a curettage is an essential part of this treatment as so often other polyps are present above the visible one. At the time of inspection any slight suspicious lesion of the portio vaginalis of the cervix requires a biopsy to rule out an incipient carcinoma. Curettage must always be studied microscopically. Adenocarcinoma is not grossly visible in its early stages which is the time for hopeful therapy.

(B) Inflammatory Diseases. Infection of the cervix, corpus, and parametrium is a frequent source of uterine bleeding, no matter what the nature of the invading organisms nor whether the inflammation involves only the uterine lining or produces such changes in the diseased ovaries as to completely

CLINIC OF DR HUGH MCKENNA
St JOSEPH'S HOSPITAL

DECOMPRESSION IN THE TREATMENT OF OBSTRUCTION
OF THE SMALL INTESTINE

IN taking up the subject of decompression of the small intestine, it may not be out of place to make an explanatory note on this procedure. When I came into the practice of surgery in the early part of this century, little attention was given to decompression of the small intestine. At that time, this procedure was carried out by performing an enterostomy in some portion of the small intestine, usually in the upper portion of the jejunum. The principles carried out by enterostomy have undergone a change because of the work of Wangensteen's suction pump combined with the intelligent use of intravenous salt solution recommended by Coller. I will first bring out some of the underlying principles we obtained by enterostomy which are now carried out as a medical procedure.

The attention of the surgical profession was directed to this type of surgical operation around 1909 and 1910 by Victor Bonney, of England, who wrote a paper on "Paralytic Obstruction of the Intestine with Special Reference to its Treatment by Jejunostomy," which was published in the Archives of the Middlesex Hospital. Singularly enough, I published a paper in the Journal of the American Medical Association in 1909 on "Paralytic Ileus," with a report of 2 cases successfully treated by operation. In 1913, I published a second paper, "Drainage of the Upper Intestinal Loop for the Relief of Ileus, Based upon Eight Clinical Cases Successfully Operated and Animal Experimentation." I wish to direct your attention to some pertinent facts abstracted from these papers.

(C) **Complications of Pregnancy**—Pregnancy is truly a fruitful source of abnormal bleeding. The frequency of spontaneous abortion is well recognized and its causes are numerous. Every effort should be made to encourage women to seek an early confirmation of the existence of pregnancy in order that they may be instructed in those precautions which will help to conserve the pregnancy.

Obviously it is vital in a patient who is spotting or bleeding and in whom there is a suspicion of pregnancy that the normal location of the pregnancy be determined. Spotting and bleeding may occur in the presence of a tubal pregnancy. The enlargement of the uterus which accompanies tubal pregnancy may add something to the difficulty of diagnosis. An accurate

test or its modifications are quite reliable. I do not like to employ diagnostic curettage nor invasion of the cul-de-sac by aspiration or incision. The clinical picture of ruptured tubal pregnancy should leave no room for doubt.

The spotting and bleeding of hydatidiform mole though infrequent requires consideration. Here the diagnosis depends upon the evidences of pregnancy, the possible quantitative Aschheim-Zondek test and the fact that advanced hydatid mole shows a breadth of uterus greatly out of proportion to its long axis. The appearance of the cystic chorionic villi is of course pathognomonic.

The treatment of each of these clinical conditions is directly related to the establishment of a correct diagnosis. Finally it is well to remember that individual patients may be afflicted with not merely one of the many causes of benign uterine bleeding which we have discussed but may bleed because of the presence of two or more unrelated pathological conditions. The more complex the clinical picture the more does the restoration of the patient's health depend upon the judgment, experience and skill of the physician in charge.

very evident she could not live more than a few hours unless the distention could be immediately relieved. After a hurried consultation with my brother, I decided to operate at once. The old incision was opened, no anesthetic being given until the peritoneum was reached when gas was administered followed by a few whiffs of chloroform. The peritoneum was quickly incised and the first loop of the intestine that presented itself was picked up. There were no signs of peristalsis, consequently only a small amount of gas escaped when the bowel was opened. It is significant to note that I made the statement then, that irrigation with salt solution was done immediately and continued for thirty minutes. It was noted that gas and fecal matter continued to escape with the irrigation, consequently this treatment was repeated at intervals of two hours. The patient was returned to her bed and given the ordinary postoperative treatment.

In my second paper referred to above the following conclusions were reached:

'Disturbance of innervation to the upper intestinal tract in the human sufficient to stop peristalsis produces the same symptoms as mechanically blocking the same amount of intestine in the dog.'

'High intestinal stasis, whether paralytic or mechanical, is much more serious than low obstruction. The fatal factor in acute obstruction may be found in the secretions from the duodenal mucosa.'

'That the fatal factor in general peritonitis may be due to a duodenal secretion and not to the effect of infection per se.'

'That when the condition of acute ileus is definitely established, the duodenum should be drained early.'

'Lastly, that the duodenum can best be drained by performing a jejunostomy.'

In 1923, I published a paper in the Journal of the American Medical Association on bowel obstruction in which I stated that it was possible to perform an enterostomy by making the attachment of the serosa to the skin in such a way that only a diverticulum would ultimately result from the side of the intestine permitting the intestinal content to move in the normal way and the fistula opening to close without any surgical procedure. As I stated before, with the advent

In Victor Bonney's report of the second case when paralytic ileus developed following radical removal of the uterus for carcinoma of the cervix, an enterostomy was performed in the ileum, no gas escaped, vomiting continued and the patient died. In his third case, symptoms of paralytic obstruction occurred twenty four hours after radical operation for carcinoma of the cervix and fecal vomiting appeared in forty eight hours, at which time the wound was reopened. Three feet of the ileum and most of the colon were found collapsed there was distention above but no peritonitis. The jejunum was opened directly and was fixed in the wound, a Paul tube was inserted for drainage. Feculent fluid drained for forty eight hours through the opening and then normal bile stained fluid was seen. This patient survived. In his conclusions Bonney stated

"1 It is proper to perform jejunostomy in all cases of paralytic ileus which have gone to the length of producing vomiting of intestinal matter other than the biliary contents of the duodenum

"2 It is useless to open the gut just above the collapsed portion

"3 In organic obstruction, where hyperperistalsis is still present above the constriction simple removal of the organic obstruction is sufficient. If there have been no colicky pains for some hours preceding the operation and paralysis of the intestinal wall may be inferred, jejunostomy should be performed

um

struction and a possible appendicitis. The patient was prepared and given an enema which was followed by the passage of considerable gas therefore the operation was not performed until the following day. The appendix was removed and hernia repaired. The entire operation did not require more than one and one half hours. The patient received the

following thirty six hours so alarming (her with respirations at

46, and the beginning of stercoraceous vomiting) that it was

her symptoms continued and since it was evident that the condition was not a tuberculosis of the ileum a second operation was performed on August 19th.

The abdomen was opened through a wide right rectus incision and the extent of the pathology surveyed. Approximately 10 inches of the terminal ileum and the small part of the cecum were directly involved with the corresponding mesentery. The ileum was markedly thickened giving the sensation of a wall over 1 cm in thickness the mesentery for a distance of 3½ inches from the mesenteric border of the bowel was over 2 cm in thickness (Fig. 79). A plastic exudate had occurred between the primarily involved ileum and the small intestine so that it was necessary to resect 30 inches of the ileum in order to get above the diseased portion of bowel. The ileorectal valve and a part of the cecum were resected with the ileum by means of a cautery. The ileum was closed by ligature purse string and layers of Lambert sutures the rectum by over and over sutures with two rows of Lambert sutures. A lateral anastomosis was made between the remaining ileum and ascending colon using extreme care in bringing down the excised margin of the mesentery and attaching it to the lateral wall of the colon in order to establish a better blood supply to this part of the intestine and also to prevent a herniation of the small intestine through this opening. Intravenous normal salt solution was given during the operation.

Following operation the patient was given 5 per cent glucose in normal saline intravenously at intervals for over a week. Considerable distention developed. A Wangensteen suction pump was set up and the intestine decompressed following which the patient made a slow but complete recovery.

Case II. Resection of Proximal Portion of Large Intestine for Extensive Adhesions Following Multiple Attacks of Obstruction. —The second case is that of Sister M. thirty two years old who entered the hospital February 26, 1932, complaining of generalized abdominal pain of four hours duration vomiting for three hours and nausea and general malaise for five hours. She had had several previous operations appendectomy in 1926 rectal abscess in 1928 and gallbladder drainage in 1929 when the surgeon found many adhesions around the intestines which he separated. She also gave a history of severe sore throat occurring every two months winter and summer with fever headache and difficulty in swallowing. She had lost 12 pounds in the six months previous to admission. Urine was negative and leukocyte count 8200. A diagnosis of acute obstruction of the bowel was made. Operation was performed immediately the large bowel was markedly distended and bound down in the region of the rectum by bands of adhesions. Many adhesions were present at the site of the previous operations. Adhesions were freed and the rectum was brought down to the lower margin of the wound for the first stage of a rectostomy. A rubber tube was inserted into the bowel and secured with purse string sutures followed by wound closure. Hypodermolysis of saline 2000 cc was given during the operation and the same amount immediately following. Gastric lavage was administered. Recovery was uneventful. Closure was made of the old colostomy on July 12, 1932. Following this operation a postoperative hernia developed and was repaired on September 19, 1932. The patient was discharged in good condition on October 15, 1932.

of the duodenal suction pump of Wangensteen, surgical decompression of the bowel may not be required. In my opinion a large percentage of these patients are saved from any form of decompression. I, therefore, wish to give the history of a patient who was operated upon for regional enteritis.

Case I Resection for Regional Ileitis—Miss E. P., a student nurse twenty years of age was admitted to the hospital June 24, 1935 on the service of Dr. L. E. Hines with a history of pain in the lower right quadrant in the region of the ovary. She had not menstruated for two months. Temperature was 99.5° F and leukocyte count 10,350. From a vaginal and rectal examination the pain seemed to be in the right uterine adnexa. She was placed on a liquid diet and an ice bag was applied to the abdomen and kept under observation. The following day she was somewhat improved. On June 27th the

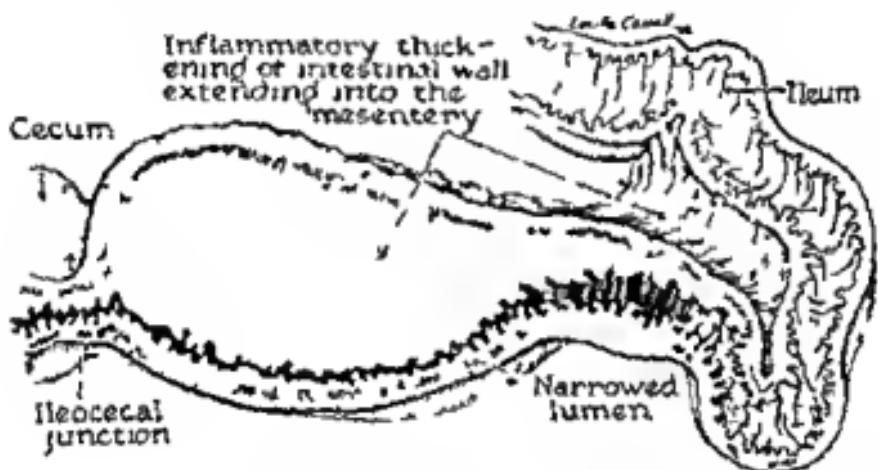


Fig. 79.—Resected portion of the terminal ileum.

tenderness appeared localized in the right lower quadrant. On the 29th an exploratory laparotomy was done. A regional enteritis was noted in the last 7 inches of the ileum in which the appendix was bound down at the base. The ileum was thickened and studded with small tubercles giving the appearance of tuberculosis. The appendix was removed as well as a heavy band tending to constrict the ileum. The involved ileum was not removed because of the possibility of tuberculosis in which event recovery would be possible without further surgery. Subsequent examination proved that it was not tuberculous. The patient made a rather slow recovery but was discharged in fair condition on July 13th.

On August 11th she was readmitted with the history of lower abdominal pain and the passage of clots of blood in the stool. Physical examination was essentially negative except for tenderness in the right lower quadrant. Temperature was 98.8° F and leukocyte count 4350. She was kept in bed for eight days and given 5 per cent glucose in normal saline intravenously. At

her symptoms continued and since it was evident that the condition was not a tuberculosis of the ileum a second operation was performed on August 19th.

The abdomen was opened through a wide right rectus incision and the extent of the pathology surveyed. Approximately 10 inches of the terminal ileum and the small part of the cecum were directly involved with the corresponding mesentery. The ileum was markedly thickened giving the sensation of a wall over 1 cm in thickness, the mesentery for a distance of 3½ inches from the mesenteric border of the bowel was over 2 cm in thickness (Fig. 79). A plastic exudate had occurred between the primarily involved ileum and the small intestine so that it was necessary to resect 30 inches of the ileum in order to get above the diseased portion of bowel. The ileocecal valve and a part of the cecum were resected with the ileum by means of a cautery. The ileum was closed by ligature purse string and layers of Lembert sutures. The cecum by over and over sutures with two rows of Lembert sutures. A lateral anastomosis was made between the remaining ileum and ascending colon using extreme care in bringing down the excised margin of the mesentery and attaching it to the lateral wall of the colon in order to establish a better blood supply to this part of the intestine and also to prevent a herniation of the small intestine through this opening. Intravenous normal salt solution was given during the operation.

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In the succeeding years patient had recurring attacks of abdominal distention which finally became so frequent and severe that a normal bowel movement was impossible. In April 1938 the abdomen was again opened through a paramedian incision. The ileum was cut off and closed by means of a ligature and purse-string suture. Anastomosis between the proximal part of the resected ileum and transverse colon was done. It was impossible to remove the ascending colon and proximal half of the transverse colon because of the patient's condition. A blood transfusion was given on the table and the patient made a fair recovery until the bowel content began backing up into the ascending colon, making a second operation necessary. On July 15th a long incision was made through the rectus muscle exposing the colon from the cecum to the rectum. The colon was firmly attached by adhesions to the abdominal wall and surrounding tissue. The colon was mobilized by cutting the mesocolon to the border of the colon and dissecting up to a distance of about 5 inches from the anus. The colon was tied off and cut by means of easily a purse string of linen being placed around the colon. The stump was then pushed back into the colon and tied. Two rows of linen sutures were placed over the end of the stump. Great care was exercised in closing the colon in order to prevent adhesions between the stump and the abdominal wall. Firm closure of the abdomen was made. Another blood transfusion was administered before the patient left the operating room.

She had a very stormy convalescence in which she was decompressed by means of the Wangensteen suction pump and given intravenous glucose and salt solution over a long period of time.

Since my early training in surgery I have been interested in the subject of ileus because of the teaching of Dr. John B. Murphy who probably as much as any other surgeon of his time realized the potential danger in connection with every acute surgical abdomen. It may be in order to note that the treatment ordered by him for distention and ileus following an operation for acute appendicitis indirectly produces a decompression of the small intestine by permitting the content to be emptied into the colon by the Murphy plan of Fowler's position and proctoclysis by the Murphy drip. It is significant to note the number of surgeons who have not followed the teaching of Murphy in the treatment of postoperative distention and ileus. He insisted upon Fowler's position the bed being kept horizontal and the back rest elevated and that the salt solution be given by the use of a grooved vaginal douche tip of the triangle type (not round) bent to an angle of 30 degrees inserted into the rectum for a distance of $\frac{3}{4}$ inch and fastened on the inner side of the thigh by means of adhesive to prevent the douche tip from slipping further in.

or out His results show the value of this method of treatment

Cannon and F T Murphy, in 1907, called attention to the effect of handling the tissues in the production of ileus, stating that even the most gentle handling under warm salt solution or in the peritoneal cavity caused marked retardation of peristaltic movements This finding has been corroborated by Cline and others

R L Holt, writing in the British Medical Journal for 1936, summarizes the position that most experienced surgeons hold respecting the treatment of paralytic ileus when he says "In using enterostomy, drainage is often limited by kinking of the gut, and virulent peritonitis is not an unusual sequel In paralytic ileus, the patient drains poorly and is almost entirely superseded by intestinal decompression by suction apparatus (Wangensteen) which is more efficient and offers none of the hazards of enterostomy

On reviewing the literature on abdominal surgery, one is impressed with the marked reduction in the incidence of paralytic ileus This is due to three chief factors (1) earlier diagnosis immediately followed by surgical intervention, (2) more meticulous handling of the abdominal viscera and particularly with the intelligent use of moist abdominal sponges, and (3) the advent of the Wangensteen suction pump combined with the proper intravenous fluids as recommended by Coller I am convinced that the second patient referred to in this clinic would have been subjected to enterostomy of the jejunum had it not been for the use of the Wangensteen pump and intravenous glucose

In closing I have attempted in the clinic this morning to review the evolution in the treatment of one of the most serious complications in abdominal surgery, paralytic ileus and bowel obstruction I have pointed out the work of the early investigators from a clinical and laboratory standpoint Important work was accomplished when the surgical profession realized that the intestinal content, probably intra enteric, undergoes a change when the peristalsis is markedly retarded As has been shown experimentally and clinically, this intestinal content following the lowering or absence of peristalsis becomes extensively distended and must be relieved, there-

fore those surgeons who at the beginning produced high enterostomy accomplished an important role in the evolution of the treatment of ileus. This procedure accomplished a twofold role, as I pointed out in one of my original papers in attempting to relieve the intestinal content normal salt solution was introduced into the lumen of the bowel first washing out the decomposed toxic content and secondly furnishing a source of chlorides since all these patients are suffering from a hypo chloremia. The surgeon who deserves most of the credit in the evolution of this treatment is O. H. Wangensteen. Mention should not be made of the treatment of decompression of the small intestine by the use of Wangensteen's suction pump without referring to the splendid work of Dr. Fred A. Collier who has placed the intravenous therapy on a scientific basis and should be used as recommended by him whenever the suction pump is used in the treatment of paralytic ileus or obstruction.

CLINIC OF DRs KARL A MEYER AND PETER A ROSI
COOK COUNTY HOSPITAL

DIAGNOSIS AND TREATMENT OF ACUTE AND CHRONIC
DILATATION OF THE STOMACH

Case I.—Miss L. R. aged seventeen years was admitted to the Cook County Hospital on August 26, 1934. About eight months ago the patient's mother noticed that her body sagged to the left and that the curvature of her spine was most pronounced while walking. She had no pain. The remaining history contained nothing of importance relative to the curvature of the spine.

Physical examination showed a curvature of the thoracic spine to the left. The remaining physical examination was essentially negative.

Roentgen ray examination of the thoracic spine showed a scoliosis to the left.

The patient was placed on a Bradford frame with traction on the spine. She remained in traction for seven and one half weeks after which she was removed and placed in a body cast. She was discharged on November 14, 1934.

The patient's course at home was uneventful until Christmas day. Shortly after eating her Christmas dinner of which she more than overindulged, she noticed a feeling of tightness in the epigastrium. The distress was more of a severe continuous pain. Her abdomen became distended and protruded through the window in the body cast.

She vomited but obtained no relief. The vomitus which at first contained undigested food later became brownish and contained somewhat foul semi-fluid material. She attempted to drink water but she would immediately vomit and belch up large amounts of gas. Her condition became progressively worse until she was readmitted to the hospital on December 27, 1934.

Physical examination on admission showed an acutely ill girl. Her temperature was 99° F, pulse rate 100, respiratory rate 22. The skin of the abdomen protruding through the cast window was edematous and cyanotic. The cast was immediately removed. The abdomen was distended. There was no tenderness and auscultation showed diminished peristaltic sounds. The remaining physical examination revealed nothing of apparent importance.

Roentgen ray examination of the abdomen showed a homogeneous shadow filling practically the entire abdomen and displacing the colon into the pelvis. In order to positively ascertain the relation of the mass to the stomach the patient was given about 50 cc of a thin barium meal. The barium was seen to enter the homogeneous mass and gradually become dispersed throughout its entire area.

fore those surgeons who at the beginning produced high enterostomy accomplished an important rôle in the evolution of the treatment of ileus. This procedure accomplished a twofold role, as I pointed out in one of my original papers, in attempting to relieve the intestinal content, normal salt solution was introduced into the lumen of the bowel, first washing out the decomposed toxic content and secondly furnishing a source of chlorides since all these patients are suffering from a hypochloremia. The surgeon who deserves most of the credit in the evolution of this treatment is O. H. Wangensteen. Mention should not be made of the treatment of decompression of the small intestine by the use of Wangensteen's suction pump without referring to the splendid work of Dr. Fred A. Collier, who has placed the intravenous therapy on a scientific basis and should be used as recommended by him whenever the suction pump is used in the treatment of paralytic ileus or obstruction.

CLINIC OF DRs KARL A MEYER AND PETER A ROSI

COOK COUNTY HOSPITAL

DIAGNOSIS AND TREATMENT OF ACUTE AND CHRONIC DILATATION OF THE STOMACH

Case L—Miss L. R., aged seventeen years, was admitted to the Cook County Hospital on August 26, 1934. About eight months ago the patient's mother noticed that her body sagged to the left and that the curvature of her spine was most pronounced while walking. She had no pain. The remaining history contained nothing of importance relative to the curvature of the spine.

Physical examination showed a curvature of the thoracic spine to the left. The remaining physical examination was essentially negative.

Roentgen ray examination of the thoracic spine showed a scoliosis to the left.

The patient was placed on a Bradford frame with traction on the spine. She remained in traction for seven and one half weeks after which she was removed and placed in a body cast. She was discharged on November 14, 1934.

The patient's course at home was uneventful until Christmas day. Shortly after eating her Christmas dinner of which she more than overindulged, she noticed a feeling of tightness in the epigastrium. The distress was more of a severe continuous pain. Her abdomen became distended and protruded through the window in the body cast.

She vomited but obtained no relief. The vomitus which at first contained undigested food, later became brownish and contained somewhat foul semi-fluid material. She attempted to drink water but she would immediately vomit and belch up large amounts of gas. Her condition became progressively worse until she was readmitted to the hospital on December 27, 1934.

Physical examination on admission showed an acutely ill girl. Her temperature was 99° F., pulse rate 100, respiratory rate 22. The skin of the abdomen protruding through the cast window was edematous and cyanotic. The cast was immediately removed. The abdomen was distended. There was no tenderness, and auscultation showed diminished peristaltic sounds. The remaining physical examination revealed nothing of apparent importance.

Roentgen ray examination of the abdomen showed a homogeneous shadow filling practically the entire abdomen and displacing the colon into the pelvis. In order to positively ascertain the relation of the mass to the stomach the patient was given about 50 cc. of a thin barium meal. The barium was seen to enter the homogeneous mass and gradually become dispersed throughout its entire area.

A diagnosis was made of an acute dilatation of the stomach following the ingestion of a large meal.

The patient was treated by gastric aspiration, eneclysis of sodium chloride and dextrose solutions, blood transfusion and pitressin. Gastric aspirations amounted to about 2000 cc in twenty-four hours but the day before her death 9000 cc were obtained. The stomach contents were dark brown. In spite of the eneclysis of large amounts of salt solution and repeated blood transfusion the patient became progressively weaker. She developed a right paroxysm. Her temperature which at first was normal gradually rose to between 102° and 105° F. She died January 4, 1938.

Postmortem examination showed the stomach to occupy almost the entire peritoneal cavity. There were multiple ruptures of the serosa and muscularis of the gastric wall in the region of the fundus. In one of the ruptures there was a perforation into the peritoneal cavity. There was a diffuse fibropurulent peritonitis.

Comment—Acute dilatation of the stomach in its milder form is a frequent occurrence during abdominal operations. It is not uncommon to see the stomach gradually dilate during a laparotomy for conditions elsewhere than in the stomach. Often the stomach reaches the brim of the pelvis within less than ten minutes. The dilatation occurs most frequently postoperatively, following laparotomies. However, practically every type of operation at one time or other has been followed by an acute dilatation of the stomach. Childbirth, acute and chronic illness or rapid ingestion of a large meal have been followed by an acute gastric dilatation. This multiplicity of conditions that may cause an acute dilatation of the stomach indicates a neurogenic basis as the probable etiologic factor. Once dilatation has occurred the dilated stomach may lead to an obstruction of the duodenum either by direct pressure on the duodenum as it passes over the spine or by forcing the intestines into the pelvis and producing an arteromesenteric compression of the duodenum. The obstruction to the duodenum has been repeatedly demonstrated postmortem.

Dragstedt and his co-workers the toxic manifestations occurring in acute dilatation may be the result of the failure of reabsorption in the lower intestinal tract of the gastric and duodenal juices, particularly the inorganic elements such as

sodium chloride. The duodenal obstruction as shown by these authors may produce changes in the selective absorption of the duodenal mucosa so that toxic substances are absorbed. These toxic substances have a secretagogue action and increase the secretion of gastric and duodenal juice. This accounts for the tremendous amount of body fluid lost through vomiting or retained in the stomach. This continuous loss of fluid particularly gastric juice leads to a change in the constituents of the blood such as fall in chlorides increase in the CO combining power shift in pH to the alkaline side and a late increase in the nonprotein and urea nitrogen. Autopsy studies in cases of acute gastric dilatation show the stomach to occupy practically the entire abdominal cavity and the intestines crammed into the pelvis and behind the dilated stomach. The gastric wall is thin and the mucous membrane flattened friable and covered with scattered erosions. The duodenum is usually dilated to the gastromesenteric vessels but beyond that the intestines are usually not dilated. The obstruction of the duodenum by the gastromesenteric vessels may be easily overcome by inserting a finger into the bowel or under the mesentery. Cases have been observed in which there was a necrosis at the point of obstruction of gastromesenteric vessels. The dilated stomach is filled with brownish fluid and air which on analysis is shown to be swallowed air.

The symptoms of acute dilatation of the stomach are usually first noticed within the first twelve to twenty four hours postoperatively but may occur as late as fourteen to twenty one days. Nausea is frequently the earliest symptom. Vomiting is the most prevalent and persistent symptom. The vomiting is frequently effortless and not accompanied by pain. The vomitus varies from colorless to bile stained and not infrequently coffee ground like it is never feculent.

Physical examination of patients with an acute dilatation of the stomach reveals few pathological signs except possibly a slight abdominal distention which is most marked in the left upper quadrant. In the more advanced cases the entire abdomen may be distended.

Laboratory examinations are of little value in the early diagnosis of acute gastric dilatation. However after vomiting has continued for days the blood shows a decrease in the

chlorides increase in the CO combining power and a late increase in the nonprotein and urea nitrogen.

Roentgen ray examination of the abdomen is of value in the obscure cases especially in differentiating the persistent vomiting of an acute gastric ileus from that of an intestinal obstruction. The dilated stomach will be seen as a homogeneous shadow filling practically the entire abdomen and displacing the colon gas shadow into the pelvis. The shadow can be identified as stomach by giving the patient about 50 cc of a very dilute barium meal. The barium fluoroscopically will be seen settling toward the lower edge of the dilated stomach.

The treatment of acute dilatation of the stomach should be directed toward evacuation of the stomach so as to relieve the direct pressure in the stomach and the pressure of the gastrointestinal vessels on the duodenum. Release of the duodenal obstruction allows the gastric and duodenal contents to enter the lower intestinal tract and be reabsorbed. Stimulation of the musculature of the stomach wall with drugs should be attempted so as to reestablish peristolic activity. Dehydration and mineral loss should be prevented by the administration of fluids and salts parenterally.

Evacuation of the stomach is best carried out by constant gastric suction rather than the intermittent gastric aspiration. Constant suction not only empties the stomach but prevents a recurrence of the dilatation by constantly removing the gastric and regurgitated duodenal juices and by removing the swallowed air which forms by far the greatest percentage of the gas in the stomach. As shown experimentally dilatation can be prevented by not allowing atmospheric air to enter the stomach.

The fluid and organic salts removed by the constant suction must be replaced. The constant loss of gastric juice as shown experimentally lead to dehydration, hypochloremia, alkalosis, tetany and death. Death can be prevented by administering fluids and the inorganic elements particularly the sodium chloride lost in the gastric juice. Clinically it is our practice to give the patients about 3000 to 4000 cc of 5 per cent dextrose in Hartmann's solution. This solution is superior to a physiological sodium chloride solution in that the

potassium sodium and calcium in Hartmann's solution help maintain an equilibrium of these positive ions in the tissues whereas the administration of sodium chloride alone if continued over a long period of time, will lead to an abnormally high concentration of the sodium in respect to the other positive ions. The sodium lactate in the solution helps maintain the normal pH of the blood.

Should the dilatation persist for days, repeated blood transfusion may help maintain the patient's resistance and furnish some body protein. Surgery, in view of our present day knowledge of acute dilatation of the stomach is of no value in decompressing the acutely dilated stomach.

Case II—Mr. W. E. M., aged thirty three was admitted to our service on October 21, 1937. He complained of epigastric pain of four years duration. Periodic attacks of nausea, vomiting, weakness and a loss of 35 pounds in the past year. About four years ago the patient first noticed a burning epigastric pain which would occur about two hours after meals. The pain was relieved by alkaline powders and food. Vomiting occurred with the pain and relieved his distress. He was placed on a dietary regime by his physician and obtained complete relief of his symptoms. The following year he noted a recurrence of his distress from which he again obtained relief with alkaline powders and diet. Since then however the pain has recurred with increasing frequency and his response to treatment has become less favorable. During the past year the pain was more and more constant. Alkaline powders gave him no relief. A course of histidine injections likewise failed to alleviate his symptoms. During this time he had lost about 35 pounds in weight. He never vomited any blood although his stools were said to have been black. The remaining history contained nothing of apparent importance relative to his stomach distress.

Physical examination at the time of his admission to the hospital showed an asthenic male. Examination of his abdomen showed no masses. There was some tenderness to the right of the midepigastrium. The abdominal and general examinations were otherwise negative. Examination of the blood showed erythrocytes 3,150,000. Leukocytes 7250. Hemoglobin 41 per cent or 8.7 Gm per 100 cc. The differential blood count showed neutrophiles 60 per cent, lymphocytes 30 per cent, eosinophiles 6 per cent and monocytes 21 per cent. The blood cholesterol was 150 mg and the alkaline reserve 88.5 vol per cent. Examination of the urine showed an albuminuria varying from 10 to 20 mg per 100 cc of urine.

Roentgen ray examination of the stomach showed a dilated stomach with vigorous hyperperistalsis. The duodenal bulb was defective but no ulcer niche was seen. There was a 30 per cent retention in six hours.

In order to rule out an obstruction on the basis of an inflammatory edema, achalasia or spasm the patient was placed on medical management which consisted of the trisaccharides of calcium and magnesium with hourly milk and cream and nightly stomach aspirations. At bed rest under this regime the patient ob-

chlorides increase in the CO combining power and a late increase in the nonprotein and urea nitrogen.

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Chronic dilatation of the stomach due to a neoplasm usually of the pylorus is associated with the general symptoms of malignancy such as anorexia loss of weight weakness and progressive anemia. Frequently considerable dilatation may be present before any vomiting occurs. Pain may be entirely absent. Likewise the severity of the pain has little or no relationship to the vomiting. The onset of chronic gastric dilatation associated with a duodenal or prepyloric ulcer is usually associated with an exaggeration of the old ulcer distress. An epigastric fulness may be noted after meals. Later the distress is often associated with cramplike pains especially following a meal containing solid food. Vomiting which occurs early after the onset of the obstruction gives the patient relief of the epigastric distress. At first the vomiting contains recently ingested food but as the obstruction progresses the vomitus becomes greater in amount and contains food ingested during the preceding thirty six to seventy two hours. The constant vomiting associated with pyloric obstruction leads to a gradual loss of the body chloride an increase in CO_2 combining power and not infrequently an increase of the blood urea nonprotein nitrogen and creatinine. This trend toward alkalosis is hastened by the prevalent practice of administering large doses of alkalis. Nervous irritability and tetany are occasionally still seen in protracted and untreated cases of pyloric obstruction. Tetany although more dramatic in its symptomatology is much less frequent than milder forms of alkalosis. In the diagnosis of chronic dilatation of the stomach the most important laboratory aid is the roentgen ray examination of the stomach.

With the aid of a barium meal the extent of the dilatation and obstruction and the nature of the obstructive lesion can be accurately determined. The response to treatment can be easily followed. Gastric aspiration motor test meals the various test meals for acid determination of the gastric juice are of distinct value as corroborative evidence and should be carried out in all cases.

The treatment of chronic dilatation of the stomach depends upon the etiological factor. If the obstruction is due to an inflammatory edema from an ulcer adjacent to the pylorus or to an achalasia or spasm of the pylorus medical management

tained relief. He was allowed to go home under management but one week after his discharge he was readmitted with a more severe recurrence than before. He was again placed on a restricted medical management. This time he failed to respond. He developed an alkalosis. The CO₂ combining power of the blood reached 92 vol per cent protein nitrogen 95 mg urea nitrogen 52.8 mg chloride 520 mg and the creatinine 49 mg per 100 cc of blood. The amount obtained at the evening stomach aspiration gradually increased until it reached between 1000 and 1500 cc. The patient was given from 1000 to 2000 cc of physiological sodium chloride intravenously daily with little effect on his alkalosis. Failing to respond on medical management it was decided that the patient's best chance for relief was overcoming the pyloric obstruction surgically. In this way the physiology of the gastro intestinal tract and tissue metabolism could be restored to normal.

He was operated upon November 30 1937. Under morphine scopolamine and 1 per cent novocain infiltration the abdomen was opened through a mid line epigastric incision. The stomach was somewhat dilated its wall was thickened and edematous. There was an ulcer in the first portion of the duodenum. On account of the patient's debilitated condition a posterior gastro-jejunostomy was decided upon rather than the more extensive gastric resection.

The posterior wall of the pars media of the stomach was united to the jejunum about 4 inches from the ligament of Treitz. The anastomosis was done in three layers two layers of continuous catgut and a seromuscular suture of interrupted fine silk. The abdominal wall was closed in layers with interrupted silk sutures. The postoperative course was relatively uneventful. He was discharged on December 29 1937. When last seen June 30 1938 he had gained about 30 pounds in weight and has had no recurrence of his distress.

Comment—Unlike acute dilatation of the stomach chronic gastric dilatation does not offer the dramatic symptomatology of the acute gastric ileus. The onset is usually gradual and the symptoms insidious so that a considerable dilatation may be present before the correct diagnosis is made. The causes of chronic dilatations are usually organic stenosing lesions of the stomach or duodenum and rarely lesions adjacent to them and involving them by direct extension. In the stomach the most common obstructing lesions are prepyloric ulcers and carcinomas. In the duodenum peptic ulceration with stenosis is by far the most frequent cause of obstruction although duodenal carcinomas, gastromesenteric ileus and periduodenal fibrosis following cholecystectomy are seen occasionally as causative factors. Some degree of gastric dilatation can occur from spasm or achalasia of the pylorus or from an inflammatory edema associated with peptic ulcers adjacent to the pylorus.

CLINIC OF DR HERMAN L KRETSCHMER
PRESBYTERIAN HOSPITAL

TECHNIC AND END RESULTS IN TRANSURETHRAL
PROSTATIC RESECTION

ANY new surgical procedure especially if it represents a radical departure from the present day established practice is always subjected to severe criticism and at once surgical opinion is divided into two camps those in favor and those opposed to the new technic

Surgical prostatectomy achieved its high plane of efficiency during a period of twenty five years During this time many notable contributions in the field of prostatic surgery were made To review them briefly they dealt with careful pre operative study and preparation of the patient with special studies of the renal function and detailed study of complications both in the lower and upper urinary tracts In addition perfection in surgical technic as well as the type of anesthesia to be selected in men of advanced years has played an important role in surgical prostatectomy

With the advent of transurethral resection a new point of view was presented in the form of treatment However there was no change in any other well established principle in the treatment of prostatic obstruction

As time went on adverse criticism of resection simmered down until at present there are only two points for discussion (1) Whether or not large hypertrophies are best treated by resection? (2) Should this procedure be followed as a routine in all cases instead of making a selection of them for resection and for surgical prostatectomy?

The literature on the subject of transurethral resection is very large and deals with careful preoperative study and preparation of the patient selection of cases suitable for resection the technic of the procedure the economic advantages

such as an adequate ulcer regime and daily aspirations of the stomach will usually alleviate the symptoms. If the obstruction fails to respond to medical management or the symptoms of alkalosis develop surgery is indicated.

Chronic dilatation of the stomach that is a result of an organic lesion of the pylorus can be relieved only by surgery either by removing the cause of the obstruction such as a stenosing ulcer or a neoplasm of the stomach or duodenum or by a short circuiting operation around the obstruction. Resection of the neoplastic obstructing lesions is always indicated even at times in the presence of metastases. By extending the limits of operability for resection of gastric malignancies one may have a slightly higher operative mortality but will offer more comfort to a greater number and extend the life span of the patients surviving the operation. It is not within the scope of this clinic to discuss the merits of gastric resection versus gastro-enterostomy for pyloric obstruction in the treatment of peptic ulcer both operations have their limitations and advantages. A careful selection of cases will give fewer disastrous complications that are now seen not infrequently following ill chosen operative procedures on the stomach.

In the type of case illustrated the loss of weight, debility, anemia and alkalosis preclude any extensive operative procedure. In these patients the obstruction should be relieved with the least amount of surgical trauma. Local anesthesia is preferable. A posterior gastrojejunostomy is the simplest short circuiting operation to perform and gives excellent results. It is our practice to do a posterior gastrojejunostomy to rehabilitate these patients. If the patients remain on an adequate medical management there is usually no recurrence of the distress. Some patients as is generally known will develop anastomotic ulcers. These too often respond to medical management and may avoid surgery. The few failing to respond should be advised to have a gastric resection. A primary gastric resection may be advised in robust individuals with pyloric obstruction from peptic ulceration and patients who have none of the early signs of alkalosis. The incidence of recurrent ulcer symptoms is much less following gastric resection than following short circuiting operations.

major problems increases more difficult cases are handled successfully. This statement applies equally to the surgeon performing gastrectomies, resections of the colon and rectum removal of brain tumors as it does to a surgeon performing transurethral resections.

The evaluation of any method of treatment must in the final analysis be made upon the basis of relieving the patient of his pathological condition and this object is to be attained with the lowest possible operative mortality the shortest period of morbidity and the procedure should be free or relatively free of complications and with a short stay in the hospital.

I do not believe that there are any differences of opinion regarding the fact that transurethral prostatic resection when compared with surgical prostatectomy has a lower mortality rate, a shorter period of hospitalization and fewer postoperative complications.

There is another point I should like to discuss a decided increase in two groups of patients affected with prostatic obstruction. It is my opinion that most urologists will agree with the following statements (1) a definite increase of patients who suffer from serious cardiac disease and who because of this condition are not suited for surgical prostatectomy a point emphasized in a previous publication¹ (2) a definite increase in the number of patients who are over seventy years of age.

It is scarcely necessary at this time to emphasize again the fact that mortality in any surgical procedure increases with each decade irrespective of the surgical procedure used. On the other hand it is generally admitted at the present time that the patients of the older age group have a much better chance of recovery when resection is done than from prostatectomy and that the older and feebler they are the more justification there is for transurethral resection. It is not uncommon to have a man of eighty or ninety years of age sent in with the specific recommendation that because of his age the family physician wishes him to have a transurethral resection instead of a surgical prostatectomy.

In a previous publication¹ I made the statement that I had performed only one surgical prostatectomy in the past fifty

of a shorter period of hospitalization the fact that there are fewer postoperative complications a shorter period of morbidity its use in bad risk cases and the advantages of the various types of instruments employed

One phase of the subject that has not received much discussion is the object of the resection and another is a consideration of the end results

Before discussing these two phases I should like to call attention to the fact that rather severe criticism has been directed against this procedure and those who employ it routinely because the patient is made to fit the operation and not the operation made to fit the patient. May not this same criticism be directed against those who use only the suprapubic or perineal prostatectomy? Do they not likewise fit the patient to their particular type of prostatectomy?

It seems to me that in this entire discussion sight is lost of a more important fact namely the object of the treatment by resection in a patient suffering from prostatic obstruction. Relief or cure of the obstruction is the objective before us and unless it is relieved no matter which method is used we fail in our effort to cure the patient but on the other hand when the obstruction has been completely removed we attain our objective namely the cure of the patient.

If one method is just as effective as the other in completely relieving the obstruction if it carries with it a lower rate of morbidity and mortality and if it can be used in patients who are poor surgical risks then it seems to me that that particular operative procedure should be the method of choice.

In the discussion of the pros and cons of resection the controversy has centered largely around the method itself and not enough consideration has been given to the human element. In other words I think the method has been criticized because of the bad results that followed its use without taking into consideration the man who sat at the other end of the resectoscope.

As a matter of fact the same general statement might apply to any surgical operative procedure.

As experience in any field of surgery increases the surgeon's results improve as evidenced by a lower mortality a shorter period of morbidity and as his ability to deal with

urea chloride 20 urea creatinine 16 Blood pressure systolic 124 diastolic 64 Wassermann and Kahn tests, negative

Examination of the urine Two plus albumin no sugar no casts 680 white blood cells per cubic millimeter and 110 red blood cells per cubic millimeter Cultures of the urines showed *Staphylococcus albus* Phenolsulfonphthalein appearance time eighteen minutes with a total of 65 per cent in ninety minutes Residual 8 ounces

Roentgen ray examination Negative for stone Intravenous pyelograms normal on the right side but on the left showed marked hydronephrosis

When the patient entered the hospital routine catheter drainage was instituted On the third day after admission he became acutely ill with chills and fever and pain in the back A diagnosis of acute pyelitis was made Because of the failure of the indwelling catheter drainage to clear up the infection and because of severe chills and fever it was decided to do a suprapubic cystostomy This was done on May 6 1937 In spite of the suprapubic drainage the fever continued and on the fifth postoperative day a ureteral catheter was inserted into the left kidney Following the insertion of the indwelling catheter into the kidney after suprapubic drainage there was a prompt cessation of chills and fever and the temperature returned to normal The catheter was withdrawn and again the patient had chills and fever The catheter was reinserted and there was a repetition of above mentioned symptoms Therefore it was decided to do a left nephrostomy This was done on May 11 1937 Following the nephrostomy the temperature gradually returned to normal A transurethral resection was performed on June 1 1937 A middle lobe and two lateral lobes were removed Following the resection the patient developed an acute pyelitis The temperature returned to normal on the eighth day after the operation

Histology benign prostatic hypertrophy

Patient discharged June 28 1937

To review briefly the problem in this case let me call your attention to the fact that indwelling catheter drainage as well as suprapubic drainage failed to clear up the severe urinary infection, therefore, it was assumed that a nephrostomy was indicated It was not until this procedure was carried out that the patient continued to improve Nevertheless, it is most unusual to follow indwelling catheter drainage and suprapubic cystostomy with nephrostomy

I should like to emphasize the fact that the preparation for resection is an individual problem In other words, one patient may need no preliminary drainage As a general rule, an indwelling catheter will suffice, but there are cases that require a suprapubic cystostomy

To reiterate, in this patient these two procedures gave no relief, necessitating a nephrostomy

one months" Since this statement was made in May, 1936, I have performed only one suprapubic prostatectomy and no perineal prostatectomies. I have made no selection of cases and have not refused treatment to any patient who presented himself with prostatic obstruction.

It is interesting in this connection to note that when an operating surgeon has prostatic obstruction he wants to have a resection, and when his patient has prostatic obstruction he performs a surgical prostatectomy.

With the improvement in the technic of resection, in the hands of various urologists, using this procedure, it is only natural that the morbidity and mortality have shown a steady decline. As a sequence, an increasing number of patients seek relief at a much earlier date than formerly. The natural result is the fact that these patients are hosts to fewer complications when they present themselves for resection. Among the complications may be mentioned severe infection in the urinary tract, impaired kidney function, recurring pyelonephritis, large hydronephrosis, bladder diverticula, and stones in the bladder.

Attention to the possibility that these complications would diminish in large measure, as the patients come in at an early instead of a later date was stressed in a previous publication.²

Although this trend to seek early relief is still on the upgrade, there are nevertheless a certain number of patients who have one or more serious complicating lesions, so that the question of the proper procedure in some of them demands careful deliberation. As an example of a case that illustrates the necessity for and the difficulty of making the right decisions, I should like to present the following case.

C K male aged sixty-nine admitted to the Presbyterian Hospital on April 11, 1937. Patient had a history of an initial syphilitic lesion many years ago for which he had received appropriate treatment. Repeated Wassermanns since treatment was discontinued negative. On admission he had frequency of urination both day and night, dysuria, burning and smarting on urination and night sweats. Recently developed chills and fever with night sweats.

Physical examination. Slight enlargement of his heart. An electrocardiogram normal. Head, eye, nose, ears, neck, chest and throat normal. Neurological examination normal. Pupils small, equal and regular, react to light. Rectal examination: enlargement of the prostate, no signs of carcinoma.

Blood count: 4,280,000 red blood cells, 8100 white blood cells, 78 per cent hemoglobin. Blood chemistry: urea nitrogen 16.6, nonprotein nitrogen 36.5.

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To reiterate in this patient these two procedures gave no relief, necessitating a nephrostomy.

During transurethral resection two difficulties that are worthy of consideration and discussion may arise

1 Accidents that may arise during resection. A review of the literature shows that although accidents are rare, they are undoubtedly of a serious nature. Of paramount importance are perforation of the bladder with resulting peritonitis, injury to the rectum or to a loop of the bowel with or without peritonitis, tears in the extraperitoneal part of the bladder with resulting pericystitis and intravesical explosions.

The prevention of intravesical explosions was discussed in a previous publication³ in which the importance of frequent evacuation of the gas which collects during resection was stressed.

Accidental perforation of the bladder and injury to the rectum probably occur when the field of observation is obscure as the result of profuse bleeding. Hence manipulation should never be done unless there is a perfectly clear field.

2 The question of hemorrhage is still a source of much annoyance and hence receives a good deal of discussion. The accurate control of hemorrhage is imperative. Hemostasis should be as complete as in any other surgical procedure. In no field of open surgery is the surgeon ever satisfied with anything less than this accomplishment. Therefore why should we be satisfied with anything less in resection?

The wash water at the end of resection should be clear or at the very most show just a faint pink tinge. I always try to have the wash water clear and colorless when the patient leaves the table. This objective can be attained with a little skill and some degree of patience.

The bleeding may be of two types. (1) During the early part of the resection it occurs from the cut surface of the prostate. Some prostates are more vascular than others hence bleed more freely. The bleeding point can be found very easily and seared with the coagulating current. In some instances it occurs not only from the cut surface but from an area that has not yet been resected. I refer to the bleeding which occurs at 12 o'clock. At times this is so profuse that the field of vision is rapidly obscured making location of the bleeding point difficult. However if one bears in mind this possibility, and if one cannot find bleeding points in the area

in which resection has been carried out, there should be no difficulty in locating and controlling the bleeding points above. In some cases when bleeding is unremitting in the early part of the resection, it becomes less and less as the resection progresses. The opposite, however, may occur.

(2) Another type is the profuse bleeding at the end of the resection. This is apt to occur in the large prostates in which a very large amount of tissue has been removed and

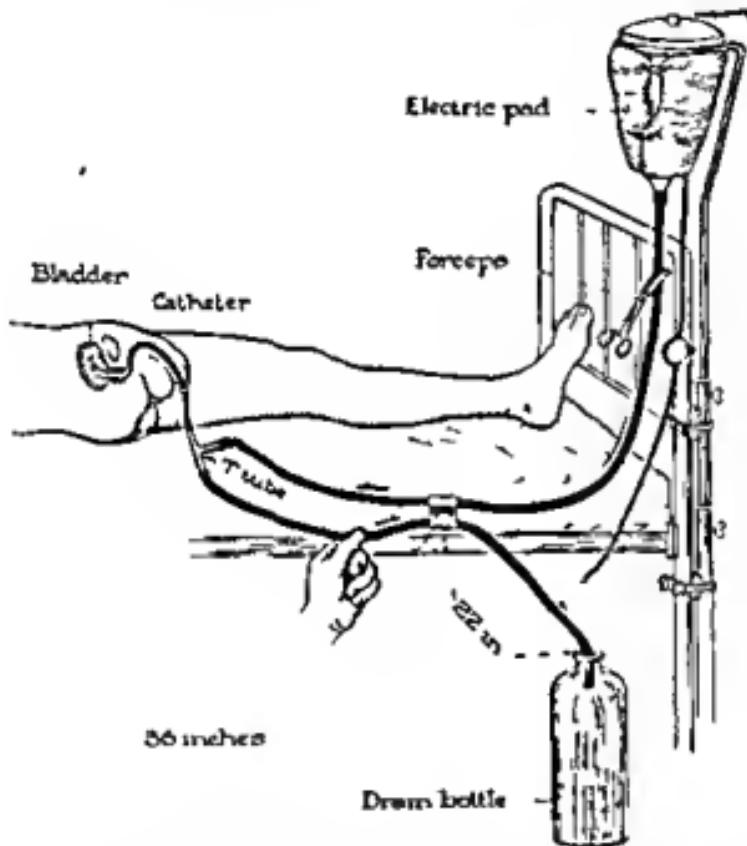


Fig. 80.—Showing one type of closed irrigating system

when one is down on the capsule. This bleeding is profuse and takes place without any cutting having been done. In-

a large amount of tissue has been removed, one must be satisfied with nothing less than complete hemostasis. At times, to

achieve this end, one's patience and endurance are taxed to the limit. However, if one persists in attempts to master the situation, one is amply rewarded by a smooth convalescence of his patient.

When the bleeding is not perfectly controlled, the bladder fills up with clots. The patient develops bladder spasms to such a degree that it is necessary to evacuate the clots, which means instrumentation. This subsequent manipulation increases the dangers of infection, with an increase in the mortality and morbidity.

In order to facilitate postoperative irrigations should these be necessary in case of slight bleeding, the end of the in-

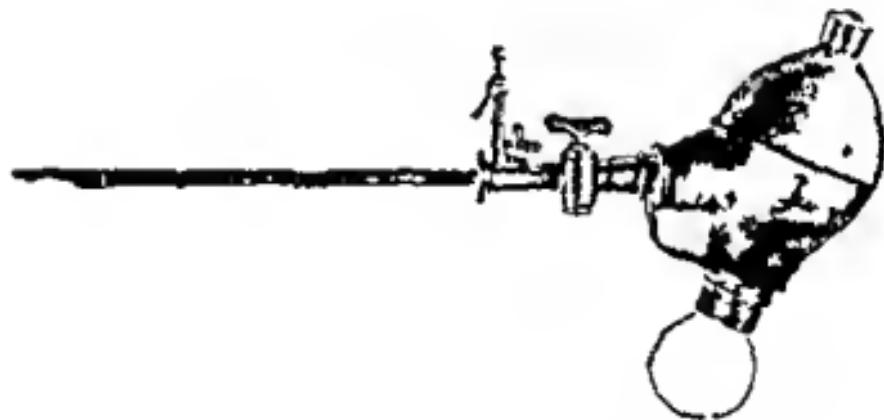


Fig. 81.—Bigelow pump used to aspirating fragments from bladder.

dwelling urethral catheter is attached to a closed irrigation system. This prevents the possibility of breaks in technic thus avoiding the possibility of the introduction of infection. Nearly everyone who uses a closed postoperative irrigation system has devised a method or system of his own. Many of these individual systems are used by large numbers of men in various parts of the country. We have found the following simple and easy to operate (Fig. 80).

We irrigate with a 1:5000 solution of hot silver nitrate solution. If there has been no bleeding the irrigation system is disconnected at the end of forty eight hours. If the urine is slightly blood tinged it is not taken down until the end of seventy two hours.

Removal of Fragments—Various methods of removing the pieces of resected tissue are in use. Some operators remove each piece, as it falls into the bladder by means of a forceps especially designed for this purpose. This has always impressed me as a time consuming procedure.



Fig. 82.—A Showing the small amount of tissue removed in Case I. B Showing the large amount of tissue removed in Case II. (Results identical in both cases.)

I prefer to allow the fragments to remain in the bladder until the end of the resection and then remove them in one sitting by attaching a Bigelow pump to the end of the resectoscope (Fig. 81) similar to the way fragments of stone at the end of litholapaxy are removed.

At the end of the resection the inside of the bladder is examined with the cystoscopic telescope to be assured that all the fragments have been recovered. If any are left behind

they may become the nucleus for a stone—in instance of which I have seen

Vasectomy—Early in my work with prostatic resection bilateral vasectomy was a routine procedure. With rapid technic and careful manipulations, avoiding unnecessary roughness, the incidence of epididymitis is so low that today I regard a vasectomy an unnecessary procedure. But there are exceptions to this rule, although they are rare. When a patient gives a history of repeated attacks of epididymitis or when, as rarely happens, he enters the hospital with an acute fulminating epididymitis, vasectomy is justifiable.

Amount of Tissue Removed—The question, frequently asked is, How many grams of tissue do you remove? In my opinion, there is only one answer—the amount of tissue to be removed in each case should be judged not by its weight, but according to whether or not the obstruction has been completely removed. Naturally, the amount varies within very wide limits. In order to illustrate my point, I should like to present the following 2 cases. The amount of tissue was very large in one case and almost negligible in the other. The amount of tissue removed is illustrated in Fig. 82.

T. K., male aged sixteen, admitted to the Presbyterian Hospital on July 30, 1938. Family and previous history irrelevant. Complained of incontinence of urine and stated that he had this symptom all his life. Also had difficulty in starting the urinary stream. Frequently felt a swelling in the lower abdomen accompanied by a dull aching pain.

Physical examination. A well developed boy of sixteen weight 114 pounds. Eyes ears nose throat and lungs normal. Heart slightly enlarged, a systolic murmur at the apex and a systolic thrill was palpable. Examination of the abdomen revealed a suprapubic tumor which persisted after the patient voided. Rectal examination showed a normal prostate. Neurological examination negative.

Blood count 4,400,000 red blood cells 8800 white blood cells 70 per cent hemoglobin. Blood pressure systolic 150 diastolic 80. Blood chemistry nonprotein nitrogen 100 urea nitrogen 82 serum calcium 9.1 serum phosphate 6.8 Wassermann and Kahn tests negative.

Examination of the urine. There plus albumin no casts and no sugar. Phenolsulfonephthalein appearance time seventeen minutes with a total output of 15 per cent in ninety minutes. Cultures of the bladder urine hemolytic streptococcus and *Staphylococcus aureus*.

Röntgen ray examination. Genito urinary tract normal. Skull plate normal. Intravenous pyelograms poor visualization. Chest normal. Lungs

incomplete formation of right first rib and slight increase in heart shadow in the region of the left auricle

Because of impaired renal function and the presence of infection patient was treated with an indwelling catheter and gradual decompression was instituted. Blood chemistry nine days after admission urea nitrogen 76 non protein nitrogen 110

A transurethral resection of the bladder neck was performed on August 8 1938. Following the resection the patient had a mild pyelitis with a temperature of 100.8. On the tenth postoperative day the urea nitrogen was 46 and the nonprotein nitrogen 55. Before his discharge from the hospital an examination showed no residual urine.

The sections removed by resection showed hypertrophic muscle tissue and pavement epithelium.

No residual urine on August 20 1938.

The patient was discharged on August 23 1938.

F J K aged fifty five admitted to the Presbyterian Hospital on May 17 1938. Previous history irrelevant. Complaints were frequency of urination both day and night great urgency and pain at the bladder neck. Also had a history of having passed gravel and repeated attacks of complete urinary retention.

Physical examination negative.

Blood count 4510000 red blood cells 11600 white blood cells 90 per cent hemoglobin. Blood chemistry urea nitrogen 18.4 creatinine 1.8 non protein nitrogen 43.5 urea chloride 32. Blood pressure systolic 145 diastolic 95.

Examination of the urine no sugar albumin blood pus or casts.

Roentgen ray examination Genito urinary tract negative for stones. Intravenous pyelograms on the right showed dilated calices opposite the first and second lumbar vertebrae on the left dilated calices opposite the first and second lumbar vertebrae. Pelvis and ureter not visualized.

An electrocardiogram showed left axis deviation and myocardial damage.

Rectal examination. An enormous benign prostatic hypertrophy as a matter of fact the prostate was so large and it extended so high that it was impossible to feel the top of it. Because of its large size I advised the patient that two and probably three resections would be necessary. The first resection was done on May 23 1938 the second on June 2 1938 and the third on June 30 1938.

The tissue removed showed benign hyperplasia.

No residual urine on July 7 1938.

The patient was discharged on July 8 1938.

As one's experience with this method grows more and more tissue is removed hence it is my belief in speaking of transurethral resection that the term transurethral prostatectomy would be justifiable.

As I mentioned earlier in this clinic, the object of the

treatment of prostatic obstruction is to remove the obstruction and if this has been completely removed a cure will result. The term "cure" may be measured in various ways. One way of determining whether or not the obstruction has been completely removed is to estimate the amount of residual urine present when the patient is discharged. It seems to me that this is a very critical evaluation of the result obtained. It is to be remembered that modest amounts of residual urine present at the time of discharge will disappear as time goes on, so that a subsequent estimation for residual urine made three months later often reveals a complete absence of residuum.

In Table I is given the results of examinations in 273 cases.

TABLE I

AMOUNTS OF RESIDUAL URINE IN LAST 273 CASES TESTED FOLLOWING TRANSURETHRAL RESECTION

| | Per cent |
|------------------------|-------------------|
| No residual urine | 707 cases (74.81) |
| 11-20 cc | 35 cases (12.08) |
| Total = 87.90 per cent | |
| 21-30 cc | 19 cases (6.9) |
| 31-40 cc | 2 cases (0.73) |
| 41-50 cc | 2 cases (0.73) |
| Over 50 cc | 10 cases (3.6) |

For purposes of comparison the results of the examination for residual urine in a series of 273 cases previously published is given in Table 2 below.

TABLE 2

AMOUNTS OF RESIDUAL URINE IN FIRST 273 CASES TESTED FOLLOWING TRANSURETHRAL RESECTION

| | Per cent |
|------------------------|-------------------|
| No residual urine | 151 cases (66.30) |
| 11-20 cc | 44 cases (16.11) |
| Total = 82.41 per cent | |
| 21-30 cc | 17 cases (6.22) |
| 31-40 cc | 5 cases (1.83) |
| 41-50 cc | 6 cases (2.19) |
| Over 50 cc | 20 cases (7.32) |

It will be noted that in the second series of cases there was a definite increase in the number of cases who had no

residual urine and there were fewer cases who had from 11 to 20 cc. In the first series, these two groups made up 82.41 per cent of the cases examined, whereas in the second series they made up 87.9 per cent.

In the first series of cases, there were 20 patients who, at the time of their discharge had over 50 cc. of residual urine, whereas in the present series, there were only 10 cases who had over 50 cc. of residual urine. For purposes of analysis these 10 cases are presented in the following table.

TABLE 3

ANALYSIS OF CASES WITH OVER 50 CC. RESIDUAL URINE FOLLOWING TRANSURETHRAL RESECTION

| | Residuum | Age | Complications | Remarks |
|-----|----------|-----|---|---|
| H S | 60 cc | 73 | | No recent check up |
| W W | 60 cc | 73 | Stricture of urethra | No recent check up |
| H B | 60 cc | 77 | Carcinoma of bladder and large diverticulum | No symptoms at present |
| J C | 60 cc | 69 | Diverticulum and bilateral hydronephrosis | No symptoms at present |
| C J | 75 cc | 72 | Muscular atony of bladder | |
| I W | 75 cc | 78 | Multiple cellules and diverticulum | No recent check up |
| E P | 80 cc | 74 | | No symptoms |
| | | | | Patient died 6 weeks after discharge from hospital of coronary thrombosis |
| V S | 120 cc | 77 | | No recent check up |
| A G | 150 cc | 76 | Small diverticulum and multiple cellules | No recent check up |
| H Z | 180 cc | 54 | Spinal cord bladder | |

Again I wish to stress the fact that, with the passing of time, the number of cases with over 50 cc. of residual urine has decreased. The following table shows the analysis of the 10 cases with over 50 cc. of residual urine.

Of these 10 cases there was no opportunity to examine 4 cases for residual urine recently. Four cases had complications hydronephrosis, carcinoma, and diverticulum of the

bladder. One patient had spinal cord bladder and another had muscular atony of the bladder which was demonstrated by means of cystometry.

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CLINIC OF DR. BUDD C. CORBUS, JR.

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THE PATHOLOGY OF THE COMPLICATIONS OF NEISSERIAN INFECTION IN THE MALE AND THEIR SURGICAL TREATMENT

WHY do complications of neisserian infection in the male arise? There are three reasons: first, they occur in direct proportion to the virulence of the infecting strain of gonococci and the resistance of the host; secondly, they may be due to mismanaged or neglected treatment; last, but far from least in importance, is the fact that both physician and patient have considered this infection as merely a manifestation of a localized inflammation.

Recently, our attention has been called to the fact that the neisserian infections are not merely a local inflammatory process but may be a serious disease of a systemic nature. During the past five years the world literature has contained innumerable reports of systemic gonorrhea in which the etiologic agent has been recovered from practically every organ in the body except the spleen. Heretofore, patients have been afforded local treatment and have gone about their daily routine and told to curb their activities along the line of spirituous ingestion and sexual excitement. And we ask, Why do complications occur under such a regime? Therefore, treatment of this disease (to be discussed in the light of it) in the necessity postulate.

With the institution of such therapy we can assure ourselves that the surgical complications presently to be discussed will be confined to a minimum.

These surgical complications are relatively few but of

sufficiently serious nature as to jeopardize the life of the individual if not given early and satisfactory care. In brief, they may be listed as follows:

- 1 Periurethral abscess
- 2 Cowperitis
- 3 Epididymitis
- 4 Prostatic abscess
- 5 Seminal vesiculitis
- 6 Stricture of the urethra

It must be emphasized that in the early stages of all these six foregoing conditions conservative treatment is absolutely indicated. Heat is the most efficacious agent for resolving the products of inflammation before suppuration and fluctuation have been allowed to take place. Diathermy has been found of great value in epididymitis, periurethral abscess, cowperitis and even stricture of the urethra. Heat applied to prostatic abscess and seminal vesiculitis by means of a rectal thermaphore has been shown to have definite advantage.

The surgical treatment to be discussed is applied only in late cases or after conservative management has been given ample trial.

1 **Periurethral suppuration** may originate through the blocking of infected urethral glands by edema, fibrosis or direct extension through the tissues or lymphatic spaces. Because of the multiplicity of the urethral glands (Littre) along the floor of the pendulous urethra, periurethral abscess occurs here most frequently. Periurethral inflammation may or may not be accompanied by extravasation of urine.

Owing to the fact that the membranous urethra is short and usually devoid of glands, periurethral infection above the triangular ligament usually takes the form of prostatitis or prostatic abscess. If a periurethral abscess originates in the submucosa or in an infected gland cut off from the urethra by fibrosis, it will contain no urine. If it is extensive and severe a secondary opening into the urethra may develop. In this case, extravasation occurs the severity depending upon whether the secondary opening is below the point of the abscess. If so, at the attempt to force urine past the stricture, the urine will escape.

into the tissues. Even a small quantity however causes rapid necrosis and abscess formation.

When this condition has become widespread before incision or rupture the fistulae may be numerous and complicated chronicity leading to fibrosis with thick inelastic fistulous tracts. In extreme cases multiple sinuses and urinary fistulae surrounded by indurated masses of scar tissue penetrate the penis scrotum and perineum in every direction exuding urine and pus. Owing to the excessive formation of fibrous tissue this painful condition is encountered more often among Negroes and has been described as watering pot perineum or chronic urinary extravasation.

The clinical picture of periurethral abscess needs no elaboration here. Suffice it to mention that any painful tender swelling in the perineum or pendulous urethra fluctuating and pointing toward the skin in line with the urethra is probably a periurethral abscess. The patients strangely enough are not systematically very sick. A common complaint is progressively increasing difficulty in the passage of urine. Total retention often brings them to the hospital.

The treatment of periurethral abscess is incision and drainage either under local infiltration anesthesia or by sacral epidural block. Spontaneous rupture may occur but incomplete evacuation of the abscess usually follows necessitating incision nevertheless.

It is believed by many that short circuiting of the urine is of value for proper drainage in these cases and thus after the abscess has been incised and drained external urethrotomy is performed. Because of the presence of infection the urethrotomy wound of necessity heals by secondary intention. The tube is removed on the seventh or eighth day and soundings are instituted weekly until the fistula is closed.

2 Cowperitis or inflammation of the bulbo urethral glands of Cowper is a rare occurrence in neisserian infections. These glands located in the bulbous portion of the urethra between the anterior and the posterior layers of the triangular ligament possess long and narrow ducts lined with cylindrical epithelium thus occlusion by inflammatory edema or increased secretion of mucus from irritation may occur. The pathogenesis of cowperitis is not thoroughly understood.

but the infection once established in the urethra is believed to spread by either direct extension or along the lymphatics. Infection of these bulbo urethral glands is seen in cases associated with chronic anterior urethritis, stricture of the urethra and cases in which retrograde injections have been mismanaged.

Owing to the anatomic situation of these glands, when suppuration occurs, pus tends to burrow in one of two directions. It penetrates the posterior layer of the triangular ligament and thus extends into the ischiorectal fossa or pus may follow the duct through the anterior layer of the urogenital diaphragm to point on the skin of the anterior perineum.

The treatment of cowperitis is both conservative and surgical. Evacuation of the glandular ducts may sometimes be accomplished by inserting the forefinger into the rectum and gently but firmly kneading the inflamed glands palpable in the anterior triangle of the perineum. In the majority of cases of intraetabular cowperitis, cowperectomy or surgical excision is the only feasible procedure. It consists merely of simple incision over the palpable glands and enucleation of the glandular elements.

3. Acute epididymitis of gonorrhreal origin is said to occur as a complication in 10 per cent of the cases in clinic practice and in about 2 to 5 per cent of the cases in private practice. About one tenth of the cases occur as a bilateral infection. The infection travels along the vas or its lymphatics from the posterior urethra and enters the epididymis at its tail or globus minor. In the acute stage the epididymis is swollen and excruciatingly tender. The surrounding tissue is edematous and congested and the overlying skin is red and tense. The visceral layer of the tunica vaginalis being adjacent to the involved portion shares in the inflammatory process with the production of a fibrinous exudate and the formation of a moderate amount of hydrocele fluid.

Suppuration is common usually from coalescence of numerous small abscesses. After definite suppuration has occurred there is usually sufficient damage to destroy the

of the infection are severely incapacitated for a few days. The entire scrotal sac will hardly tolerate palpation, the temperature is often elevated to 103° F. and signs of systemic toxicity are evident.

Epididymotomy may be indicated in those cases in which definite fluctuant suppuration occurs. Hagner has been the main proponent of this type of operation. An incision about 5 to 6 cm. long is made in the skin, fascia and tunica overlying the point of juncture between the testicle and the epididymis. Multiple puncture wounds in the epididymis are made and if pus is seen to exude the opening is enlarged and thoroughly probed. If a tenotome is used instead of a knife injury to the tubules of the epididymis is thought to be less. All pus is evacuated and the cavity thoroughly cleansed with a sterile irrigating solution. The wound is closed in layers leaving in a small gutta percha drain.

Those who advocate immediate surgical treatment of acute gonorrhreal epididymitis claim more immediate relief of symptoms and therefore a lessening of the chief pathological consequence that of sterility. However this point is not wholly agreed upon.

4 Prostatic abscess occurs in one twentieth of the cases which have prostatic pathology. It may be of primary or secondary origin. The latter as a manifestation of general sepsis cannot be included in this discussion. The primary or gonococcal abscess occurs in patients with a history of previous urethral infection and therefore pathologically is virtually secondary to a posterior urethritis or seminal vesiculitis. Symptoms such as frequency, urgency, burning and terminal hematuria are the rule. Mechanical as well as symptomatic difficulty in urination frequently presents itself for the abscessed prostate like the hypertrophic prostate impinges upon the patency of the internal urethral orifice. When a young man in his thirties without demonstrable stricture complains of acute retention and a significant elevation of temperature with a history of gonococcal infection, abscess of the prostate must be foremost in the line of diagnostic possibilities.

The diagnosis is established in these cases by the rectal findings. The prostate feels swollen, hot, tender and fluctuant in one or more of its portions. Often a palpable

fluctuant vesicle may be felt in addition on one side the so-called pus tube in the male. It must be emphasized that abscess of the prostate evolves from an acute prostatitis and the time required for liquefaction and fluctuation of the involved area is the same as the time required for any other area of suppuration to localize and point. For this reason prostatic abscess remains undiagnosed only too often because of failure to bear in mind the pathological sequence of events. The surgeon feels the prostate rectally, encounters no areas of fluctuation and pronounces that there is no abscess. Three or four days later a consultant sees the patient, finds fluctuation which has developed in the meantime and makes a correct diagnosis of abscess.

In our experience recently a twenty-nine-year-old male entered the hospital complaining of difficulty in urination and a temperature of 104° F. Catheterization repeatedly was effected with ease and the bladder was completely emptied. Daily rectal examinations were performed and not until the seventh day after admission was a definite fluctuation palpable in the right prostatic lobe. During the following forty-eight hours a superficial lumbar abscess and pyoarthritis of the right elbow joint developed. All the abscesses were promptly evacuated and recovery was uneventful.

All patients with acute prostatitis must be carefully observed from the standpoint of potential abscess formation. Perineal tenderness, painful defecation and retention of urine are all significant findings when preceded by urinary symptoms. Immediately upon diagnosis of prostatic abscess, prostatectomy is indicated.

Contrary to the recommendation of other authors we do not believe in the necessity of radical perineal exposure for proper drainage. In our experience simple perineal prostatectomy has proved entirely satisfactory. The patient is placed in the lithotomy position (Fig. 83-1) after having been given sacral epidural block anesthesia with 25 to 30 cc. of 2 per cent solution of novocain. Two small oblique incisions

are made, the forefinger of the left hand having been placed in the rectum.

for a guide), and the ischiorectal fossa is traversed and the prostatic capsule pierced. The closed forceps (see Fig. 83 3) is then plunged into the center of the fluctuant area, the instrument is opened and slightly moved from right to left and forward and backward. With the aid of gentle but firm

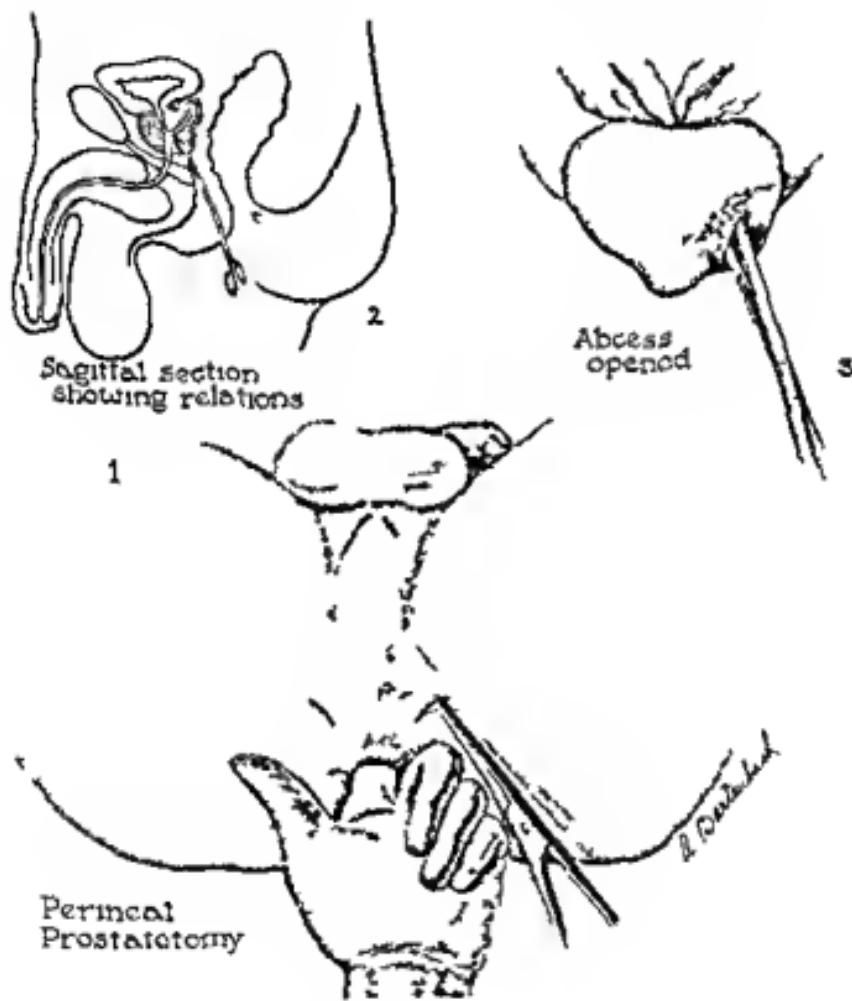


Fig. 83.—Technic of prostatectomy

digital pressure from the opposing hand pus should readily pour from the perineal opening. This process is repeated on the opposite side as small abscesses contingent to the main area often lie within the medullary portion of the gland and cannot be readily detected with the examining finger. Trans

fluctuant vesicle may be felt in addition on one side the so-called 'pus tube' in the male. It must be emphasized that abscess of the prostate evolves from an acute prostatitis and the time required for liquefaction and fluctuation of the involved area is the same as the time required for any other area of suppuration to localize and point. For this reason prostatic abscess remains undiagnosed only too often because of failure to bear in mind the pathological sequence of events. The surgeon feels the prostate rectally, encounters no areas of fluctuation and pronounces that there is no abscess. Three or four days later a consultant sees the patient, finds fluctuation which has developed in the meantime and makes a correct diagnosis of abscess.

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6 Stricture of the Urethra.—This phase of the complications of gonorrhea in the male is undoubtedly one of the most difficult to treat satisfactorily. In none of the other complications does the treatment comprise such a complicated procedure which must be fitted with variation to each patient anew. For a thorough understanding of the proper treatment of stricture of the urethra an accurate conception of both its etiology and its pathology must be borne in mind. Writers commonly refer to gonorrhea as the sole etiologic agent in the production of stricture. This was formerly thought to be true but with the advent of the more modern treatment of gonococcal infections strictures are seen to occur less and less frequently. Thus one is forced to admit that careless treatment such as needless instrumentation and overinjection are almost as important factors as the initial infection.

Pathologically speaking a gonorrhreal stricture is the cicatrix formation resulting from a chronic anterior urethral inflammation. The infection becomes chronic because of the involvement of numerous glands along the line of the urethra which do not drain because of ductular blockage by inflammatory exudate or periadenitis. When this exudate progresses to fibrosis, scar tissue is formed in the muscularis and submucosa of the urethral wall. As characteristic of all scar tissue it tends to contract the lumen of the urethra becomes diminished. Add to this a residual inflammation or superimposed attacks of acute inflammation and a vicious circle is formed which results in a progressive diminution of the caliber of the urethral lumen. Grossly the scar usually accompanied by areas of active inflammation will appear angular and pearly white being plainly distinguished from the surrounding urethral mucosa.

In the satisfactory treatment of strictured urethrae the first thing to bear in mind is their location. In what portion of the urethral canal do they occur? It is generally believed that 70 to 75 per cent of strictures occur in the vicinity of the bulbomembranous junction and the remaining 30 to 25 per cent anterior to this point.

The importance of knowing the location of the stricture is evidenced by the fact that strictures of the bulbomembranous region are found to contract to a greater degree than those

urethral prostatotomy with a sound has been recommended, but on account of the unnecessary trauma inflicted on the walls of the posterior urethra, we do not advise it.

The foregoing procedure is simple and rapid and affords complete drainage of the abscess, thus avoiding the inconvenience of radical perineal exposure.

5. Seminal vesiculitis is a complication of posterior urethral infection. There is little uniformity of opinion concerning the frequency of occurrence. Figures quoted range from 2 to 59 per cent of the cases. It is probable that in 4 to 6 per cent of all cases specific posterior urethral inflammation is complicated by coexisting vesicular infection.

Histologically, the seminal vesicles are similar to the fallopian tubes in the female. The lining epithelium consists of thin trabeculae or villi projecting into the lumen and anastomosing with one another. In acute seminal vesiculitis, edema and congestion of the mucosa occur without involvement of the deeper structures. The contents of the inflamed vesicle consist of a thin watery material which contains flakes of pus and blood typical of a catarrhal inflammation elsewhere. In chronic vesiculitis the infection extends beneath the epithelium and cellular infiltration with fibrosis occurs in the submucosa and muscularis. The villi become thickened and coalesce and form pockets in which the infection may be buried for a long time. Owing to lack of drainage it is within one of these pockets formed either by edema in the acute stage or by fibrosis in the chronic stage that an abscess originates.

Patients with acute seminal vesiculitis or abscess are symptomatically very sick. The temperature usually is about 101° F. and a variable amount of fumiculitis may be present with tenderness to pressure anteriorly. The diagnosis of course, rests upon palpation of an enlarged painful and tender vesicle per rectum.

Conservative treatment with gentle stripping of the vesicle every three to five days will in the majority of cases be satisfactory. However in cases of long standing intractable infection vesiculectomy is indicated. The perineal exposure under spinal anesthesia such as is done for perineal proctectomy, is performed allowing complete exposure of one or both vesicles and the ampullae if necessary.

between visits. Thus he would appear in two four eight sixteen and thirty two weeks. It is good practice however never to permit a patient to allow the stricture to remain unsounded for more than six months at a time.

One of the most prevalent sources of failure in the successful management of strictured urethra is the neglect of the physician to make his patient understand that *periodic sounding is necessary for the remainder of his life*.

When a stricture cannot be calibrated and entered only with a filiform bougie the process varies slightly. Sometimes it takes prolonged and patient manipulation with a filiform to find the orifice of the stricture. Often multiple filiforms introduced into the urethra distended with lubricating fluid facilitate finding the orifice of an elusive stricture. It is well to remember that in stricture of the pendulous urethra the urethral orifice is usually on the floor of the lumen whereas the inverse is true of stricture in the bulbomembranous portion. If and when a filiform only has been passed a woven or metal (Le Fort) follower is attached preferably size 14 F and passed making sure the connection between the filiform and the follower is firmly intact otherwise the filiform may be lost within the urinary bladder. Graduated sizes of followers are used in the same manner as sounds until 18 F or 20 F is reached when sounds or bougies are employed.

In cases in which no instrument can be introduced operative interference is necessary.

For stricture of the meatus simple meatotomy under local anesthesia is all that is required. For strictures of the pendulous and scrotal urethra internal urethrotomy with an Otis urethrotome is performed best under caudal anesthesia only after prolonged attempts at instrumentation have been unsuccessful. For strictures of the bulbomembranous portion by far the most common external urethrotomy is required.

The technic for external urethrotomy is as follows: the patient is placed in the lithotomy position after having been given 100 mg of novocain crystals intraspinally or 30 to 40 cc of 2 per cent novocain caudally. A grooved staff is introduced into the posterior urethra and pushed downward against the perineum which is incised directly upon the groove in the midline until the bulbous urethra is opened at a point distal

situated anteriorly. Often, a stricture which clinically appears to be multiple is single pathologically, its various fibrotic trabeculae leading to the misconception.

The patient's symptoms have little reference to the underlying pathology. Chronic urethral discharge and urinary retention, either partial or complete, are commonly encountered. The progressive diminution of urinary stream in a patient too young for prostatic hypertrophy is pathognomonic.

The diagnosis is made by the passage of the olivey tip bougie sound or urethroscope. The olivey bougie a complete set (6 F to 28 F) of which is necessary for the proper

If the stricture is of larger caliber than the bougie, this obstacle is overcome with a jump if too small to admit the bougie it is withdrawn and a smaller one is introduced until passage through the stricture is accomplished.

If the sound passes and of necessity engages the stricture, there is a grasping of the instrument which will require more force to remove than was necessary to introduce. Ordinarily a sound in a normal urethra will fall out by its own weight. If the sound fails to pass a smaller size should be resorted to until finally one that is passable is introduced. Only in the event of a large caliber stricture should a urethro-cope be used and then its recommendation is given with great caution.

Thus with the passage of an instrument of given size the caliber of the urethra at its strictured point has been determined.

The treatment of stricture of the urethra in which calibration has been performed is a relatively simple matter. Once the size of the stricture has been ascertained a sound or urethral bougie is introduced which corresponds to that size. The patient is instructed to return every five to seven days for further dilation. At each visit the largest sound used at the last treatment is introduced first followed by the next

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MICHAEL REESE AND Mt SINAI HOSPITALS

THE DIFFERENTIAL DIAGNOSIS OF DISEASES OF THE COLON

THE diagnosis and differential diagnosis in diseases of the colon bring up more difficult problems than in diseases of most any other organ. There is no part of the intestinal tract which may have more complicated pathology and yet fewer symptoms than the colon. The average patient may have such minor symptoms for so long a time that frequently when he decides to consult a physician or surgeon it is only after he has had the symptoms from six months to two years. These symptoms are likely to be so mild that even the experienced internist and surgeon may overlook a carcinoma, observe the patient for months and treat him for chronic appendicitis or one of the various colitis. The real diagnosis of carcinoma is made later when the patient finally comes with obstructive symptoms due to an annular carcinoma of the lower colon.

The first significant symptom to which the patient usually does not pay much attention is a change in the habits of the bowel movement such as a change of time of bowel movement or having bowel movements every other day or having an occasional loose stool. Naturally the patient notices this but since he has no pain is not alarmed and pays no attention to it. Yet this may be the first symptom of an early carcinoma of the colon. The patient may then experience an occasional cramp to which he pays no attention and considers it just an ordinary stomachache and yet this slight cramp may be due to hyperperistalsis over a small lesion of the bowel wall. It is only when this occurs repeatedly and at too short intervals that he will consult a physician or surgeon. The physician or

to the stricture. The edges of the incised mucosa are held with an Alhs forceps, and a grooved director conforming to the curve of the prostatic bed is introduced along the grooved staff into the bladder. The urethral staff is then withdrawn, and with the grooved director used as a guide, the stricture is incised until a 30 F rubber tube can be introduced. Scar tissue is cut away, the urethral roof, whence epithelium regenerates, being spared at all times. The tube is first irrigated with a weak solution of permanganate of potash and then anchored in place with a wide stitch of silkworm gut suture.

The patient is given 3000 to 4000 cc of fluid daily, and the perineal tube is removed on the fourth or fifth day. Sounding is started on the tenth day with a 24 F sound and is repeated thereafter every five to seven days until the wound has completely healed by second intention.

External urethrotomy without a guide when the urethra will admit no instrument is a difficult procedure. With the aid of a dye such as methylene blue which has been milked back into the bladder, the urethra and stricture orifice may be found after blind incision of the perineum. If this cannot be done readily, suprapubic incision and retrograde catheterization by means of a suitable instrument is advisable.



Fig. 84.—Early carcinoma of ascending colon



Fig. 85.—Same as Fig. 84 but after air inflation

surgeon examining such a patient with the above history may come to the conclusion that it is an appendix which is bothering him especially if he has some tenderness over McBurney's point in the right iliac region or he may conclude it is due to gallstones especially if there is tenderness in the upper right quadrant. If upon x-ray findings the colon appears normal which it may the small lesion is overlooked if the x-ray reveals gallstones. Many a patient has had such symptoms in which the x-ray findings showed gallstones and the patient was operated upon for the gallstones while the real lesion which gave him his symptoms was an early carcinoma in the colon which was overlooked on account of the gallstones. Therefore we want to point out that it is sometimes extremely difficult to make a differential diagnosis when the patient is suffering from gallstones or may even have a tender appendix and yet the real cause of the symptoms is an overlooked carcinoma in the colon.

Probably the next most common difficulty in early diagnosis of lesions of the colon is in the patient who has small hemorrhoids of which he becomes conscious on account of protrusion or pain on bowel movement or a small amount of blood in the stool or after bowel movement. He goes to an experienced surgeon who is too busy to go through a careful examination of which the most important is a digital examination of the rectum followed by proctoscopic and barium or contrast enema examination. He sees the protruding hemorrhoids and makes the appointment for the operation. This is one of the most serious and most common mistakes that medical men and surgeons make not because they do not know any better but because they do not take the time. A careful digital rectal examination on this patient may show an early carcinoma 2 to 4 inches up in the rectum from which the patient is suffering in addition to the hemorrhoids which can be seen. We have seen time and again cases of carcinoma which have been recently operated upon for hemorrhoids by experienced surgeons who did not take the time to make careful digital rectal and proctoscopic examinations.

The next most important factor in an early diagnosis of lesions of the colon is found in the patient who comes to the physician complaining of a mild degree of distress in the



Fig. 84.—Early carcinoma of ascending colon



Fig. 85.—Same as Fig. 84 but after air inflation

abdomen from gas distention and occasional tenderness in the right or left side. Without careful rectal stool or x-ray examinations a diagnosis of colitis is made and the patient is treated medically with atropine etc. to relieve the discomfort which is caused by an early carcinoma within the colon. Although it is possible for an early carcinoma of the colon to be overlooked in the most experienced hands there are three important diagnostic measures which should never be neglected by an internist or surgeon namely a careful digital rectal, a proctoscopic and sigmoidoscopic examination a barium enema followed by a contrast air distention enema or a mucosal pattern examination of the colon (Figs 84 85). When one has done carefully these three important diagnostic examinations as well as taken a careful history one will rarely overlook an early lesion of the colon or rectum. The fourth important point is to examine the stool for blood on a meat free diet repeatedly and over a long period of time.

Having these important diagnostic aids in mind we must ask ourselves What are some of the important lesions in the colon which we have to differentiate? First there are the benign growths such as polyps which may be single and are mostly confined to the lower sigmoid and rectum and the primary multiple polyps of the entire colon. Occasionally we find fibro-adenomas and hemangiomas of the colon. The most important lesions of the colon of course are the malignant tumors of which adenocarcinoma is the most common and important one. There are occasionally found some of the other malignant tumors such as sarcoma, endothelioma, neuro

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the acute perforating type and a more chronic type which give intermittent symptoms of acute exacerbations. The diverticula are usually confined to the upper rectum and lower sigmoid. There are however the other types which are congenital and many times familial in character and extend over the entire colon.

Another important inflammatory process of the colon is the phlegmonous infiltration usually found in the sigmoid region which has as its basis an inflamed diverticulum. The next im-

portant are the ileitis and ileocolitis which are many times of the infiltrative type but in the colon may be a combined infiltrative ulcerous type which may extend from the cecum along the ascending colon and well on to the transverse colon. And last the most serious of them all is the idiopathic chronic infiltrative ulcerative colitis which may affect portions of the colon but in most instances the entire colon. We may finally add the amebic dysentery colitis in its end stages when it is sometimes very difficult to diagnose and is only recognized at autopsy. There is one other not so common condition of which we may speak—Hirschsprung's disease or megacolon, which may involve the entire colon or just the sigmoid portion.

The single polyps which are usually found in the rectum are quite common in young children. They are usually within easy reach of digital examination and need nothing more than ligation or excision of the pedicle with a cautery knife. The most common symptom is hemorrhage from the rectum. This same condition is also found in adults but bleeding is not so common in adults. The multiple polyposis of the colon is an entirely different condition (Figs. 86-87). On proctoscopic examination these polyps vary from the size of a small split pea to that of a small olive but most of them are of the very small type and extend over the entire colon. These patients have diarrhea with blood streaks in the stool and sometimes marked anemia. The severity of these symptoms varies in different individuals. There are some cases relatively few in number in which multiple polyps are confined to the sigmoid and rectum and none in the descending, transverse and ascending colon. Some of these cases are so severe that primary ileostomy followed by colectomy must be resorted to. On the other hand there are many cases which may be treated conservatively for many years. This type of primary polyposis must not be confused with the multiple polyposes that are seen as an end result of chronic ulcerative colitis. The latter are merely the remaining mucosal islands in the ulcerative process of ulcerative colitis which can be easily demonstrated by proctoscopic and sigmoidoscopic examination. These polyps as well as the polyps of ulcerative colitis can be easily shown by roentgenographs of mucosal patterns and barium and contrast enemas.



Fig. 86.—Polyposis marked in the transverse and sigmoid



Fig. 87.—After air inflation

The diagnosis of carcinoma of the rectum and colon must be ascertained from the very mild symptoms described previously to that of an acute intestinal obstruction without any previous symptoms whatsoever given or noticed by the patient. When a patient past forty comes to the hospital with a distended abdomen with all the typical signs of obstruction and on whom there has been no previous abdominal operation, the most common cause of such an obstruction is an annular carcinoma in the upper rectum or rectosigmoid which is usually relieved by a cecostomy or ileostomy. It is surprising the large number of cases that come to the hospital as an emergency acute intestinal obstruction without the patient having had a single previous symptom.

Another common symptom in the rectum and rectosigmoid which is of diagnostic importance is the complaint of a patient that he has some soreness in the left side with an occasional cramp and occasional blood streaked stool. This must be differentiated from a diverticulitis and an acute inflammatory diverticulum of the rectosigmoid which usually gives more severe pain, more local tenderness, more fever, seldom any bleeding or blood in the stool and for several days runs more of an acute stage with fever, high leukocytosis and marked local tenderness. The final direct diagnosis, however, of carcinoma of the rectum and sigmoid can usually be made by the three cardinal methods such as a careful history, rectal examination, proctoscopic and barium enema. Those in the rectosigmoid and lower sigmoid are much more apt to be annular and obstructive than those of the lower rectum. A very large percentage of those within 3 or 4 inches of the rectum are usually confined to one side of the wall of the rectum and are the so called "butter plate" or disk type carcinoma, in contradistinction to those which are higher up in the rectum. The amount of blood which comes from lesions of the left side is usually not so marked as in those of the right side. A carcinoma of the cecum usually has a good deal of hemorrhage and associated marked anemia. This is due more to the character of the carcinoma in the cecum than to the blood supply or character of the chemical content in the cecum. In other words, the carcinomas of the cecum are of the soft sloughing and ulcerative type while those of



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the left side of the colon are more commonly of the solid and scirrhouss type of carcinoma and hence do not bleed so easily. Occasionally carcinomas of the sigmoid and rectosigmoid and also those of the cecum penetrate through the peritoneal covering of the bowel and one or two loops of ileum become adherent to this lesion and become infiltrated and occasionally penetrate to form an ileo- or jejunosigmoid or cecal fistula which gives additional symptoms of prostration and marked diarrhea with extreme loss of weight and emaciation. It is sometimes extremely difficult to differentiate such a case from a similar perforation which can occur in a diverticulitis of the sigmoid. There is one important diagnostic point to which we would like to call attention and that is that many times carcinomas of the colon are multiple. It is not so unusual to resect the cecum, the ascending and part of the transverse colon only to find the patient come back six months later with a carcinoma in the splenic flexure or descending colon or in the rectosigmoid. Careful histologic comparison of these multiple lesions would lead one to believe that they are probably carcinomatous implants and are probably carcinoma cells that are carried along the current of the fecal stream and implanted. We see many more such multiple carcinomas when the primary lesion is in the cecum or ascending colon than when they are primary in the rectum or rectosigmoid.

The direct diagnosis of the phlegmons of the sigmoid and left side of the colon usually due to a perforating or acute perforation of a diverticulum is characterized by the following symptoms. Some pain in the left iliac region with marked soreness and tenderness to touch which may even be noticed on slight coughing or on walking. The patient may have this for several days and then this pain becomes more severe and he makes the characteristic statement that his left side feels as sore as a boil which is correct because the patient is suffering from what amounts to a boil in his sigmoid. In addition to the local tenderness and pain he has a certain amount of rigidity which varies with the amount of peritoneal involvement, a high temperature and a high white count. A large number of these cases subsides completely with rest without any surgical interference. There is a smaller percentage which perforate and give a local or generalized and sometimes a fatal

peritonitis. When such perforation has occurred in spite of the fact that it may be only local we believe immediate ileostomy will save the patient's life in addition to making a left rectus incision lifting the sigmoid into the wound for drainage. We feel that in all the real acute cases this is the safest and most conservative procedure. In the more chronic ones with acute exacerbations the diverticulum will many times perforate into another hollow viscous such as the ileum, the urinary bladder, the transverse colon or into the cecum. Many times the actual decision can only be made at operation in this acute stage as to the differential diagnosis between carcinoma and a phlegmonic sigmoiditis due to perforation of a diverticulum.

The so called ileitis and ileocolitis which are one and the same disease may be chronic, subacute or very acute at the onset simulating an acute suppurating appendix. In a number of instances we have opened the patient for an acute suppurative perforating appendix only to find a very acute ileocolitis in which 2 feet or more of ileum were markedly infiltrated and inflamed as well as the cecum and ascending colon. The glands in the mesentery were as large as olives. The temperature was 104° F and the white count well over 20,000. In all of these cases the acuteness of the process was so extreme and the patient so ill that a temporary ileostomy was performed proximal to the infiltrative process in the ileum. The diagnosis of the more subacute and chronic types of ileitis and ileocolitis is made by the history of slight cramps and local pain on the right side by the feeling of a mass of the infiltrated cecum and ileum usually a leukocytosis and finally by the x-ray findings of the typical string effect of the ileum which is usually shown in a mucosal pattern.

The last and probably the most serious if not as serious as carcinoma of the colon is the idiopathic chronic infiltrative ulcerative colitis. To our minds the most important point in the disease is to make an early diagnosis. This can usually be done by history in which there are several weeks of multiple loose stools which finally become bloody with pulse fever, malaise, prostration and generalized tenderness over the abdomen. There are some peristaltic cramps in the abdomen. The number of stools at first may be only 2 to 3 a day.



Fig. 88—Early ulcerative colitis of the sigmoid with thickening of the wall
Mucosal pattern



Fig. 89—Same as Fig. 88, after air inflation

but finally go up to 10 or 20. After all the laboratory findings except for a leukocytosis, ameba and all the various dysenteries having been ruled out by stool examinations the final diagnosis of idiopathic ulcerative colitis is made by proctoscopic and sigmoidoscopic examination. This shows an edematous bowel reddish in appearance with multiple small ulcerative bleeding points. We think it is most important if possible to make a definite early diagnosis of this disease because we are great believers that as soon as a diagnosis is established an immediate ileostomy should be performed to save the patient's colon if not his life. The symptoms may be so severe as to give abdominal rigidity and actual perforation. If perforation has not occurred ileostomy will usually relieve the rigidity and the acute process. In the more chronic stages the patient has a slight fever, a fairly marked anemia, a tender abdomen which may not be uniform along the colon with recurrent exacerbations of fever and bronchitis. The bronchitis is probably due to embolic infarcts from the inflammatory process of the colon. Finally there is a marked subacute or chronic arthritis in which a number of joints such as the knees and elbows become involved. The x-ray findings by this time in the more chronic cases will show that the colon has contracted markedly in length. It has lost about one third of its length. The hepatic, splenic and sigmoid flexures have been almost completely obliterated and the colon may in the x-ray findings be in the shape of a horseshoe (Figs. 88-89). It shows the typical defect of multiple ulcers as can be shown by mucosal pattern and proctoscopic examination. At this time the colon may show many contractures so the proctoscope can hardly be passed and many times can be passed only 2 or 3 inches up the rectum on account of structures in it.

CONCLUSIONS

- 1 The diagnosis of diseases of the colon is many times difficult on account of the mild symptoms which are produced.
- 2 Digital rectal examination for carcinoma of the rectum, proctoscopic and sigmoidoscopic examination, roentgenographic examinations with barium and contrast air enemas as well as mucosal patterns and the examination of stools on a meat free diet done routinely will avoid errors.

3 The differential diagnosis between a perforating carcinoma and a perforating diverticulum is sometimes extremely difficult

4 Ileocolitis is many times confused with acute appendicitis

5 Early diagnosis of chronic and subacute idiopathic ulcerative colitis is most important to save the patient's colon as well as his life

CLINIC OF DR. RALPH BOERNE BETTMAN*

MICHAEL REESE HOSPITAL

THE DIAGNOSIS AND TREATMENT OF ACUTE CHOLECYSTITIS†

(This clinic deals only with cases of cystic duct—not common duct obstruction)

Case I—Acute Cholecystitis with Perforation into the Peritoneal Cavity.

Case II—Acute Cholecystitis with Immediate Cholecystectomy

Case III—Acute Cholecystitis, Immediate Cholecystostomy and Later Cholecystectomy.

Cases IV and V—Acute Cholecystitis with Spontaneous Subsidence and Later Elective Cholecystectomy

In my clinic this afternoon we will study acute cholecystitis. Much has recently appeared in the literature on the subject and as frequently happens in surgery, the writers are divided into three main camps—the revolutionaries, the conservatives and those who take the middle road. The revolutionaries would have you operate upon all cases of acute cholecystitis as soon as the diagnosis has been established, just as in acute appendicitis. The conservatives would have you wait always until the signs of acute inflammation have subsided. And the "middlers" who have written the least but who I am sure comprise the largest number and, if the truth were known many of the revolutionaries and conservatives as well, believe that each case must be decided for

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itself and treated, not according to any set plan but according to individual indications.

Now, as is usually the case in polemics, you can learn much from either side. The revolutionaries have certainly shown us that cholecystectomy can safely be done in the presence of a so-called "acute gallbladder." They have also shaken us out of any false sense of security we might have felt regarding the lack of danger of spontaneous rupture into the general peritoneal cavity. The conservatives, on the other hand have shown us that spontaneous remission in the case of acute cholecystitis is the rule, and that cholecystectomy at a later date can be undertaken with a very low mortality.

The cases I am going to present to you this afternoon are chosen from a large series of cases of acute cholecystitis with the view of verifying as many of the arguments of both the revolutionaries and conservatives as possible and to show thereby why I prefer the middle way. I have further chosen these few cases so that I might show you in which instances I personally feel immediate operation is necessary and in which I prefer to wait, and in which cases I feel that cholecystectomy can be done immediately and in which I think it wise to perform a cholecystostomy as the first procedure.

Case I. Acute Cholecystitis with Perforation into the Peritoneal Cavity.—The first case to be presented can I am sorry to say be presented by record only. He was a man in the late forties who a month previous to my seeing him had had some sort of violent abdominal upset which was cured by cathartics. The day before admission to the hospital he suddenly developed abdominal pains which became more and more severe. He vomited many times. When I examined him I found a very sick looking patient with diffuse abdominal rigidity more so on the right than on the left. He had a temperature of 101.8° F and a white blood count of 26,000. The most likely diagnosis seemed to be acute peritonitis secondary to a ruptured viscus probably the appendix. One thing was obvious that the patient was desperately ill from some type or other of acute abdominal catastrophe and that immediate surgical intervention was indicated. He was given an intravenous infusion of glucose and saline while the operating room was being prepared.

The operation was performed under ethylene anesthesia. Because of the possibility of the condition being secondary to ruptured appendix or appen-

and the duct ligated and then the abdomen was closed around 4:00 P.M. to the liver bed because the necrotic area seemed to extend into the liver

The patient seemed better for several hours after the operation, then became worse again and in spite of the usual treatment died about thirty hours later of symptoms typical of fatal peritonitis.

The importance of this first case in my clinic this afternoon lies in the fact that several facts concerning acute cholecystitis are emphatically brought out.

First and foremost, it shows us that acute gallbladders can perforate and when they perforate, may perforate either directly into the peritoneal cavity or into a poorly or ineffectually walled off space. Thus, it definitely establishes the fact that our fears of a perforation are not groundless and that any attitude toward an acute cholecystitis other than apprehensive concern is false. Secondly, it demonstrates the difficulty in diagnosing a type of fulminating gallbladder condition. When I saw this patient within twenty-four hours of the onset of the last attack, the only possible diagnosis was "acute surgical belly." There was no question whether conservative or radical treatment should be instituted. The whole picture demanded immediate operation.

It is this type of case which is confusing the issue. The patient died of an acute peritonitis after operation, not because of the operation. We would have no right to use this as a case in point to show the danger of operating in an acute stage.

Thirdly I would like to call your attention to the fact that we are worried about the ability of the liver to withstand the shock of an acute cholecystitis and that one of the arguments in favor of early operations is that by so doing a certain amount of liver damage may be avoided. Furthermore I want to call your attention to the desirability of aiding the liver by means of intravenous glucose infusions.

Furthermore you will note that every case of acute cholecystitis which you will see this afternoon has a stone obstructing the base of the gallbladder or the cystic duct. I will not

say that a noncalculous acute cholecystitis cannot occur, but I will say that in man it is extremely rare. As you know, it can be produced in dogs by intravenous injections of Dakin's solution.

Case II Acute Cholecystitis with Immediate Cholecystectomy.—The second patient who, fortunately, can be shown in person is this young unmarried woman the sister of a doctor. She had had several attacks of abdominal pain associated with nausea which her brother diagnosed as atypical appendicitis. A short time ago she was vacationing in Michigan about two and one half hours' drive from Chicago where she developed one of her usual attacks. She had abdominal pain which was severe, continuous and more in the right flank than in the left, she was nauseated and vomited and felt relieved after a hypodermic of morphine. Being anxious about her condition she had a friend drive her into Chicago and to the hospital.

When I examined her I found a sick looking young woman lying in bed and complaining bitterly of severe pain in the lower right abdomen. Her temperature was 102° F and the white count 28,000. There was marked rigidity over the entire right side of the abdomen and a point of most exquisite tenderness to the right and just below the umbilicus. The physical examination was otherwise essentially irrelevant.

The diagnosis was not definite. It was evident that there was a severe inflammatory peritoneal reaction. The previous history and the tenderness in the lower right abdominal quadrant made the diagnosis of a ruptured appendix a probable one although the suddenness of onset and the marked upper abdominal rigidity made it difficult to rule out a ruptured peptic ulcer with drainage into the right flank or an acute cholecystitis in the presence of a low lying gallbladder.

Here, as in the previous case the only thing that was certain was that immediate surgical intervention was called for. Through a right rectus para median incision the abdominal cavity was opened. The gallbladder was greatly distended extending down to the left of the umbilicus thus accounting for the low point of tenderness. It was red and edematous, the omentum was free and there seemed to be no attempt either of the omentum or the colon to wall off the inflamed viscera. The base of the gallbladder was exposed and a fairly large stone could be palpated in the cystic duct. The gallbladder was aspirated and about 100 cc of mucopurulent fluid was evacuated. This reduced the size of the gallbladder and permitted me more easily to expose the cystic duct.

swifly dissected out of its edematous bed. The stone which this is is brought along with her and which you can see now blocked the cystic duct. The walls of the gallbladder were greatly thickened and edematous, the mucosa

was especially involved and in several areas was necrotic. The gallbladder contained a large amount of mucopurulent fluid as I have said and many other small stones. No bacteriological studies were made but I wish to call your attention to the many articles in the literature concerning the absence of bacteria in the gallbladder contents in an acute suppurative cholecystitis. The abdominal incision was closed without drainage. The patient made an uneventful convalescence.

Now almost a year later she tells us that she is feeling well and that she has had no more of her appendiceal attacks in spite of the fact that her appendix is still with her or better within her.

I have presented this case to emphasize the following points in our study of acute cholecystitis. First, I again am demonstrating an acute cholecystitis in which no attempt apparently was being made either by the omentum or the bowel to wall off the gallbladder in case of rupture. Of course this was an early case and rupture was not imminent. But the complete absence of even the finest fibrinous adhesions was startling. Second this patient is but one of many which I could show you in which cholecystectomy has been performed in the presence of an acute cholecystitis without any obvious reaction. The uneventful convalescence which most of these patients make bears out the contention that this procedure is safe. Personally I never institute drainage in a case such as this where all the infected tissue is removed. However, I will admit that if the surgeon cares to leave a Penrose tube in place as a drain it certainly would do little harm and would be justifiable if it helped the surgeon's peace of mind. We have abandoned routine drainage of gallbladder cases for many years and have as yet never regretted it.

Here again we have a patient with an acute cholecystitis in whom there could be no question of conservative treatment. The diagnosis was uncertain and so far as I am concerned the condition never could have been differentiated with any degree of assurance from ruptured ulcer or ruptured appendix both of which conditions would have demanded immediate surgical intervention. The slight difficulty in freeing the cystic duct and demonstrating the common duct can be used for a point for argument of the conservatives who point to the difficulty in working on inflamed tissue. On the other hand when it came to the actual removal of the gallbladder, the edema actually helped us.

Case III. Acute Cholecystitis Immediate Cholecystostomy and Later Cholecystectomy—The next patient is an example of a large group of patients with acute cholecystitis in whom diagnosis of the condition can definitely be made but in whom for one reason or another it seemed advisable to operate during the acute stage and in whom a cholecystostomy rather than a cholecystectomy seems indicated.

This well nourished healthy looking individual was admitted to my service two years ago. She gave us the following history. She had had attacks of upper abdominal pain for many years increasing in frequency after the birth of her last child. She had been told that these attacks were due to gallstones and operation had been advised. Butasmuch as she could control these attacks fairly well by diet she postponed surgical treatment. Three days before admission she started having abdominal pain. The usual remedies relieved her slightly but after a while the pain became more severe and constant and localized in the right upper quadrant with radiation to the right shoulder blade. She became nauseated and later vomited. At first she had no fever but later developed a high temperature."

By the morning of the third day she was very sick. She had constant severe pain nausea and frequent vomiting. She finally called her family physician who immediately recognized the seriousness of her condition and sent her to my service.

On admission to the hospital she had a temperature of 103.4° F rectally pulse 130 and respiratory rate of 28. Blood count revealed 23,000 white cells with a polyneutrophil count of 94 per cent. The abdomen was moderately distended and there was definite rigidity in the right upper quadrant marked tenderness on palpation and findings which led us to write on the record. We think we can feel a mass probably distended gallbladder.

The diagnosis obviously was acute cholecystitis probably empyema of the gallbladder. It was also obvious that the condition which was now seventy two hours old was fulminating and getting worse instead of clearing up. Whether or not the gallbladder was walled off, whether a perforation was imminent, whether the obstruction of the cystic duct was fixed or might perhaps disappear were all vital questions which so far as I could see were unanswerable. If the obstruction maintained itself as it had already done for three days and if the gallbladder wall were gangrenous and if dense adhesions had not formed walling off the gallbladder then the only outcome which could be expected would be perforation with a fatal peritonitis. The risk of waiting was indeed grave. On the other hand the task of performing a laparotomy and actually ascertaining the true nature of things was comparatively minimal.

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there was an area of gangrene about the size of a penny. There were many firm omental adhesions. The adhesions however were bandlike and in no way walled off the gallbladder from the general peritoneal cavity. The gallbladder was tense and apparently contained many stones. There was no doubt

in my mind whatsoever that this gallbladder soon would have perforated at the gangrenous site and from what could be seen at the time of operation would have perforated freely into the peritoneal cavity. A cholecystectomy here would have been extremely difficult. As I have said there were many adhesions the bowels were distended and the patient was a very poor risk. There was no question in my mind that the simplest and least traumatic operative procedure adequate to drain the gallbladder was the procedure of choice and that procedure consisted of a cholecystostomy.

The fundus of the gallbladder was walled off with saline soaked sponges and the gallbladder was aspirated. 100 cc of thick bile stained pus was removed. A stab wound was made through the gangrenous area and many small and medium sized stones evacuated. A large stone was palpated but seemed firmly fixed. A rubber drainage tube was sutured into the gallbladder opening. The sponges were removed the peritoneum stitched to the gallbladder walls laterally and medially and a small bit of rubber dam placed against the ante-hepatic border. The incision was closed allowing the fundus of the gallbladder and the drainage tube to protrude.

The patient was returned to her bed in better condition than when she was brought to the operating room and continued to make an uneventful convalescence. She was allowed to go home some twelve days later with a drain age tube *in situ*. The drainage had been profuse for the first few days but later consisted of but a few cubic centimeters a day of a clear mucous fluid showing that the cystic duct had remained occluded. Frequently after a few days when the edema subsides the drainage becomes bile stained showing that the occluding stone has slipped back into the body of the gallbladder. In this instance this did not occur but either way it is of little moment. Although the patient was entirely symptom free the drain was kept in place. We prefer to keep the gallbladder drained to prevent the recurrence of an attack although in all probability had such an attack occurred it would have caused spontaneous direct rupture along the site of drainage.

The likelihood that this patient would have remained cured by the cholecystostomy alone was a very slight one. I remember clearly the experience of my intern days, at which time there were many people alive who had had cholecystostomy for the 'cure' of gallstones and I can remember that one of the most common indications for cholecystectomy was for the relief of these recurring cases. What the percentage of recurrence of symptoms following cholecystostomy is, I do not know. My own surgical experience comes chiefly within the days of cholecystectomy and so I cannot quote from my own figures but judging from the literature the percentage of recurrence is large.

We have made it a rule except in very old individuals or where for some other reason operation is contraindicated,

to advise cholecystectomy following cholecystostomy. We usually like to allow from six to eight weeks to elapse between the two procedures.

Thus it was that two months later this patient returned to us and through this transverse incision, which you can see here, we removed her gallbladder. The gallbladder was shrunken, thick walled, fibrotic. There were some few bandlike omental adhesions. The gallbladder contained one large stone the size of a hen's egg impacted not in the cystic duct but at the base of the gallbladder. Cholecystectomy following cholecystostomy is not necessarily a difficult procedure. It is true that there are usually many adhesions, especially around the fundus of the gallbladder but these can be dissected free and tax the surgeon's patience much more than his ability. Surprisingly enough the base of the gallbladder and the region of the ducts is very frequently free of adhesions. This "easy" field at the ducts is often in striking contrast to the condition in acute cholecystitis where the gland overlying the cystic duct is apt to be swollen and engorged and where the surrounding tissues are edematous and apt to ooze. Inasmuch as the important step in all cholecystectomies consists in isolation of the cystic duct and visualization of the common duct, the fact that these structures are easily approachable is a great help.

Convalescence from the cholecystectomy was uneventful. That was two years ago and since then the patient has been in good health in better health she says than at any time since her last child was born.

I am showing this patient this afternoon as an example of that group of cases who I feel require surgical intervention during the acute phase of cholecystitis. Furthermore I wanted the chance to recommend for your consideration the advisability of quick simple gallbladder drainage that is cholecystostomy in extremely ill patients or in patients where cholecystectomy might be difficult. Furthermore I wished to tell you my opinions as to the advisability of following up cholecystostomy with a cholecystectomy wherever possible. In elderly patients or in patients who are extremely poor surgical risks we frequently forego cholecystectomy, continuing instead the gallbladder drainage. In a young individual however, I think it is a mistake to leave the gallbladder in place.

and that wherever possible within two months after cholecystostomy a cholecystectomy should be done

This brings us to our last two cases of this afternoon. For the sake of emphasis I should have liked to present a dozen or more similar patients because these patients' histories are typical of the majority of cases of acute cholecystitis, namely, an acute attack which subsides spontaneously. In order to have painted the picture of acute cholecystitis accurately, most of the emphasis of my discussion should have been on the subject of this type of patient and I want you to realize, therefore, that in order not to weary you I am showing you but 2 patients who are symbolic of the majority.

Case IV Acute Cholecystitis with Spontaneous Subsidence with Later Elective Cholecystectomy—This woman in her forties is the mother of 4 children. She had had several mild attacks of gallbladder colic and has known that she is the possessor of gallstones for many years. One evening she experienced a very severe sharp pain in her abdomen just below the right costal margin associated with nausea and vomiting. I was called to see her and found her in agony. Her temperature was about 100° F by mouth. There was marked rigidity of the upper right rectus muscle and tenderness over the gallbladder region. She herself made the diagnosis of gallbladder colic only as she said infinitely more severe than any previous attack. The pain subsided somewhat after a hypodermic of morphine and a warm electric pad over the painful area gave her still more relief. A white count showed 19,000 cells of which 83 per cent were polymorphonuclears. The next morning her temperature was 101° F and rigidity was still present and so was the tenderness. She was still nauseated but had not vomited. Her white count was 22,000 and I had her moved to the hospital for more careful observation. I could have held no brief against any surgeon advising operation at that time and I will admit that I myself was strongly tempted to do so and furthermore I have been similarly tempted again and again. The only reason I was willing to wait was that the patient did not look very sick, did not seem to be getting worse and was in a place where she could have very excellent observation. By afternoon there was definite sign of improvement. The pain was slightly diminished and the nausea had disappeared. Her temperature had not increased although her white count was up to 25,000. By evening she was still better and at midnight she was sleeping peacefully without having had any hypnotic. By the next morning she was entirely free from pain had a desire for food a normal temperature and a white count still of 19,000. The following day she was able to go home. There was no difficulty whatsoever in convincing her of the need for a cholecystectomy and the only trouble was in persuading her to wait at least a month. She consented to this only after we had promised her that if during the interval there should be the slightest sign of another attack we would operate immediately. I have several times seen

recurrent attacks come on before the desired interval of four to six weeks has elapsed and in every case I have done an immediate cholecystectomy at the very start of the recurrent attack and have had no trouble

A month later almost to the hour our patient returned to the hospital free of all symptoms. At operation a gallbladder full of stones was removed. There were no signs of acute inflammation. There were practically no adhesions to the gallbladder. The convalescence was uneventful and here you see this patient eight years later in excellent health.

This patient is demonstrated because I wanted to bring to you the following facts. First, *that the spontaneous subsidence of acute cholecystitis is the common occurrence*. It is what happens in the vast majority of cases. In how large a percentage it occurs is difficult to say because many of these patients never come to the hospital or probably, for that matter, do not even call a physician. Second the history and physical findings in this case closely resemble those in whom the gallbladder would have perforated had we let them alone. 'And there is the rub.' Clinical experience backed up by extremely careful observation of the patient and by willingness to be guided by the picture as it changes from hour to hour, is necessary to solve this problem. Third *I demonstrate this patient to show what I think is the desirable and safest sequence where it can be done* watchful waiting, allowing the acute attack to quiet down, a prolonged period of further waiting to allow the inflammation to subside and then later a cholecystectomy to prevent further attacks.

Case V Acute Cholecystitis Spontaneous Subsidence—The final patient to be shown today is this fifty year old woman whose first admission to the hospital was six and one half weeks ago with a history of having had repeated attacks of gallbladder colic. The morning of admission to the hospital she was wakened by a severe upper right abdominal pain with radiation to the right shoulder blade. She was nauseated and vomited several times. Her physician gave her a hypodermic of morphine and sent her to the hospital. She had all the characteristic symptoms and findings of acute cholecystitis. She had a long history of gallbladder trouble—severe pain in the upper right abdomen radiating to the back, nausea, vomiting and a temperature of 102° F. There was marked right upper abdomen quadrant rigidity, tenderness and vague findings suggesting a mass. The white count was 16,000. She was sick but her condition did not seem to be particularly alarming. She was put to bed and ice pack applied over the gallbladder region. The cold seemed to give her comfort. She was given continuous intravenous infusion of 10 per cent glucose and then 5 per cent in saline. She was permitted to have sufficient morphine hypodermically to keep her comfortable.

Morphine was given advisedly. If the patient is in the hospital and carefully watched I do not think that the use of morphine in any way increases the hazard. By being carefully watched I mean of course just that not simply being put in a bed and seen once or twice a day.

Her general condition was constantly observed by a special nurse. Her blood count was taken three times the first two days and the temperature and pulse taken every three hours. She improved almost immediately due to the analgesic effect of morphine and to the restoration of the fluids and saline lost through vomiting and the sugar which had not been supplied by eating. The temperature remained around 102° F all day but by midnight started to come down. The next day the highest temperature was 101° F and white count dropped to 14,000. Thereafter for three days she had a slight fever of 100° F each afternoon but by the fifth day her temperature remained normal throughout the day. The white count by that time was 10,000. By the end of the week the patient was allowed to go home.

A month later or two weeks ago she returned for cholecystectomy. Here you can see the incision through which I operated. When the peritoneal cavity was opened in this case we found that the gallbladder was completely imbedded in dense adhesions which took careful dissection and much patience to free. The gallbladder when finally exposed was found to be small, contained many small to medium sized stones. The area around the bile ducts was comparatively free of adhesions and it was a simple matter to isolate the cystic duct. The common duct was visualized and found not to be enlarged nor to contain any stones by palpation. The gallbladder was removed without difficulty and the patient has made an uneventful convalescence and is ready to go home tomorrow.

Here again we have a patient whose course was typical of that of the majority of cases of acute cholecystitis, namely, a history of chronicity an acute flareup and spontaneous subsidence. In this instance furthermore the adhesions surrounding the gallbladder were so dense that even had the gallbladder perforated there would have been no danger of peritonitis. There is no question in my mind that this walling off process occurs very frequently and that those who say that a gallbladder will not perforate into the general peritoneal cavity are undoubtedly right in the majority of instances. However as I have shown you this afternoon this cannot be relied upon.

Had I time I would like to show you several other patients in whom we have watched an acute cholecystitis subside spontaneously. In some of these we have not performed a secondary cholecystectomy until a second or third attack occurred and in some over ten years has elapsed and there has still been no recurrence.

Conclusions—We have seen a group of patients this afternoon, each one representing some phase of the problem of acute cholecystitis. As I said at the start of our clinic I would be able to demonstrate the truth of many of the arguments of groups who believe in immediate operation. I have also shown you two patients where I could have shown you fifty showing the reasons why many others never operate in the acute stage if they can possibly help it and I hope I have demonstrated the middle road by the clinic as a whole.

We have seen that acute cholecystitis may go on to perforation into the general peritoneal cavity and that it is wrong to assume any attitude toward acute cholecystitis other than great apprehensive concern.

We have seen 2 cases of spontaneous subsidence of acute cholecystitis and we have emphasized that this is the usual course of affairs.

We have demonstrated that in certain cases of acute cholecystitis cholecystostomy is the procedure of choice and have also shown that in other cases cholecystectomy can be safely performed in the acute stage without fear of spreading the infection.

In other words I have tried to demonstrate that if the problem is approached from the point of view of the individual case rather than from the standpoint of routine we will get our best results. My own experience has been most gratifying. The first patient presented to you today it is true was from the record of a fatal case but that patient was doomed long before he got to the hospital and died from the generalized peritonitis incident to the ruptured gallbladder and not from the operation. Two other cases have died strangely enough from embolism one a patient who had had a cholecystostomy during the acute stage and was about to be taken to the operating room for the cholecystectomy she collapsed while helping to lift herself to the operating cart. The other patient died suddenly on the twelfth day after simple cholecystectomy which had been performed six weeks after subsidence of the acute attack.

In closing I wish to emphasize that in the determination of which type of treatment is to be pursued in any given case the one most important factor the surgeon has to rely upon is his clinical judgment.

CLINIC OF DR. MICHAEL L. MASON

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PLASTIC SURGERY OF THE HANDS

THE great amount of interest shown today in the repair of injuries to the hand is evidence of their increasing importance. The reports of industrial commissions, insurance boards and accident surveys have shown that injuries to the hands and fingers make up 10 to 15 per cent of the total number of injuries. It is due to Kanavel that the principles formulated by him have formed the basis of the present development of reparative surgery of the hand.

In a very real sense any surgery of the hand may be considered to be plastic surgery. Incisions for the drainage of infections must be so placed as to lead to a minimum of scar contractures. In the excision of new growths the surgeon should preserve as much of the function of the hand as the adequate removal of the tumor permits. The management of open wounds not only demands prompt healing with a minimum of scar formation but also the immediate repair of nerves and tendons so their function is more quickly restored. The repair of nerve, tendon and cutaneous defects must be considered to be plastic surgery with especial regard to function, while in the correction of congenital defects the surgeon must attempt to secure both a more normal appearing hand and a functioning one.

I should like to present one general topic which touches upon many fields of hand surgery and two somewhat more limited or specific topics. I do this for a quite definite reason. Restorative surgery of the hand cannot be considered from the standpoint of one operative procedure alone. The repair

of a single tendon may entail numerous operative procedures, and the suturing of the tendon may be one of the simplest of the steps. The repair of a burn of the hand may require preliminary skin grafting to obtain initial healing. There may then follow long periods of physical therapy and traction splinting to mobilize joints and soften tissue. After this the first thin graft may need to be removed and replaced with a pedunculated flap with generous amounts of subcutaneous fat, and this followed at an appropriate interval by the grafting of tendons. Lastly there is needed another period of physical therapy and traction splinting.

I thought therefore that I would like to present first a series of cases illustrating the indications for skin grafting in surgery of the hand to exemplify the wide applicability of this procedure. I should then like to show a patient with Dupuytren's contracture and lastly several patients with tendon injuries which have required secondary repair.

SKIN GRAFTING

The grafting of skin is indicated in the repair of many conditions of the hand. In some instances the skin graft may be the sole operative procedure necessary for example in the covering of raw granulating surfaces left by burns and abrasions. At times skin grafting is associated with other operative procedures such as the separation of web fingers in congenital deformities, the excision of scar tissues of burn contractures or the removal of fascia and badly contracted skin in Dupuytren's contracture. Not infrequently the secondary repair of nerve and tendon injuries requires the preliminary application of a pedunculated flap before suture or tendon graft can be undertaken. Lastly there are certain conditions such as tumor and irradiation dermatitis in which diseased skin is excised and replaced by healthy skin.

Case I—(Passavant Memorial Hospital No. 1 279 April 1934) T. R., eighteen years of age, was sent to the hospital for treatment of a granulating wound of the left forearm, wrist and hand which followed a crushing injury received eighteen days previously. There was an infected granulating wound with hard thick edges (Fig. 90) on the lower forearm and wrist and an indurated scar running downward to the base of the first metacarpal. In addition to this there was a fracture of the second metacarpal base and luxation



Fig. 90—Case I. Granulating wound the result of crushing injury received eighteen days previously



Fig. 91—Case I. Healing has been obtained by means of a split graft but the resultant scar is thick and contracted

of motion of the metacarpophalangeal joint of the index finger. The boy was hospitalized for a few days during which time the granulating wound was

dressed daily and sponge pressure applied to reduce the surface infection and an incidental scabies brought under control. The raw surface was then covered with a thin razor graft taken from the thigh and complete healing of the defect obtained (Fig 91). However, because of the fibrous reaction in the deeper subcutaneous tissues and in the scars which had already healed at the time of the first operation there was still limitation of flexion of the wrist. Therefore a few months later the tenth a star was excised and a free full thickness graft was applied (Fig. 92).



Fig. 92—Case 1. The previous graft and scar have been excised and a free full thickness graft applied.

This case illustrates the principle of the immediate coverage of raw surfaces. This can often be accomplished immediately after the injury and will save the patient many weeks or months of care and dressings. If a crushing injury can be seen at once it is often possible to excise all devitalized skin and replace it immediately with normal skin. If the patient is not seen until later and a raw granulating infected surface has formed the indication is the same, *i.e.* to close the raw area as soon as possible. In this situation however several days or more of careful frequently changed dressings and sponge pressure are needed to cleanse the surface sufficiently to permit application of a skin graft. Not infrequently even such delayed secondary closure with a split graft will yield a satisfactory result. However there are occasions such as illustrated here in which deep and extensive fibrosis will neces-

sitate the subsequent excision of the scar and a second graft. At the second operation we have the advantage of working in a clean field and can use free full thickness grafts or pedunculated flaps as the situation might indicate.

Case II.—(Passavant Memorial Hospital Nos 11163 and 16527) R. K., nineteen years of age was admitted to the hospital for care of congenital webbing of the index, middle and ring fingers of the left hand (Fig. 93 a). These had been separated when he was quite young but the web had reformed immediately and held the fingers somewhat more rigidly together than before. Correction of the webbing was accomplished in two operations. At the first operation in July 1932 the index and middle fingers were separated as far proximalward as possible. The common digital structures to the contiguous borders of the fingers were found to bifurcate quite low down and limited the depth to which the web could be divided. The defect left by the dissection



Fig. 93.—Case II. Congenital syndactyly previously operated upon with reformation of the web. a Condition before operation. b following separation of index and middle fingers and insertion of free full thickness graft. c following separation of middle and ring fingers and insertion of skin graft.

was covered with a free full thickness graft. The result of the two operations is shown in Fig. 93 c.

The separation of congenitally webbed fingers may be quite simple or quite difficult. The operative procedures so frequently illustrated consisting of shifting of flaps from the volar surface of one finger to the dorsum of the other and vice versa and of volar or dorsal flaps to fit into the web look very nice on paper but do not work in practice. If the web is quite wide and there is a good deal of skin it may be possible to split it and obtain flaps sufficiently large to cover a part of the

defect on the lateral sides of the fingers. The web space however in the region of the metacarpophalangeal joints can not be adequately closed with these flaps and too frequently they are sutured under tension and undergo necrosis and infection with resultant scar and reformation of the web.

It must be remembered also that the fusion of tissues in syndactyly may involve not only the skin but other soft tissues and bones as well. Separation of the fingers must



Fig. 94.—Splint cut from heat-shrunken to which the hand is fastened after operative separation of fingers and skin graft.

therefore be done very carefully under complete hemostasis with a blood pressure apparatus so that the blood vessels and nerves can be seen and protected. A low point of division of the vessels may restrict the height to which the web can be carried.

The web should be divided as high up in the palm and dorsum as the metacarpophalangeal joint slightly higher on the dorsum than on the volar surface as is the normal separation. This will always seem too high and the tendency is to

make the web too short. After the separation of fingers has been accomplished an exact pattern is made of the raw surfaces on the sides of the fingers and web. The pattern will be roughly spindle shaped, with the ends of the spindle representing the raw surfaces on the sides of the finger and the central part representing the web space.

In cases in which 3 fingers are fused it is sometimes possible to divide both webs at the same time and apply grafts into each defect. There is however some element of risk in this since there may be fusion or some other anomalous condition of the blood vessels and it is unwise to risk operative damage to both sides of a finger. Also the skin graft must be dressed with sea sponge pressure and there is some added risk from this pressure if the vascular supply has been disturbed.

At the termination of the operation the hand is placed on an aluminum splint with the individual fingers cut out (Fig 94) and widely separated. The sea sponge pressure is applied after the hand has been secured on the splint and great care taken that every part of the graft is subjected to the pressure. It is necessary to pad the splint carefully to avoid pressure areas over the metacarpophalangeal and proximal interphalangeal joints on the dorsum. The first dressing is done at the end of eight or nine days, but the splint and pressure are reapplied at each dressing for three weeks at which time if the graft is entirely healed the pressure may be discontinued. The splint however should be fitted with straps and buckles and worn for another three to six weeks, at first continuously, later at night only.

In situations in which the bones are fused it may still be possible to separate them and apply a full thickness graft. In our experience this fusion has occurred most often at the distal phalanx and such fingers with their fused nails should be separated. Curiously enough the cancellous bone of the distal phalanges has formed a good bed for skin grafts. However in such cases there is a marked tendency for the fingers to deviate laterally after separation and it is necessary to apply light corrective aluminum splints which the patients should wear for six months or a year after operation.

Case III—(Passavant Memorial Hospital No 35375) C. W., a boy, five and one half years of age came for correction of a scar contracture of the

defect on the lateral sides of the fingers. The web space however in the region of the metacarpophalangeal joints can not be adequately closed with these flaps and too frequently they are sutured under tension and undergo necrosis and infection with resultant scar and reformation of the web.

It must be remembered also that the fusion of tissues in syndactylism may involve not only the skin but other soft tissues and bones as well. Separation of the fingers must



Fig. 94.—Splint cut from sheet aluminum to which the hand is fastened after operative separation of fingers and skin graft.

therefore be done very carefully under complete hemostasis with a blood pressure apparatus so that the blood vessels and nerves can be seen and protected. A low point of division of the vessels may restrict the height to which the web can be carried.

The web should be divided as high up in the palm and dorsum as the metacarpophalangeal joint slightly higher on the dorsum than on the volar surface as is the normal separation. This will always seem too high and the tendency is to

extension is not possible the fault may lie in the joint capsules which have contracted. We have occasionally divided the capsules to obtain correction but this is not often necessary since extension splinting after operation will usually secure the remainder of the correction.

Case IV.—(Passavant Memorial and Cook County Hospital Nos. 29598 and 28709) E. S., a bell boy twenty-eight years of age sustained a laceration across the right antecubital fossa while washing windows December 18, 1935. He was given first aid and transferred to a hospital where an attempt was made to repair the wound and to suture the divided nerves. The wound



Fig. 96 Case IV Pedunculated flap applied to volar surface of elbow after excision of scar tissue preparatory to nerve repair.

became infected and four days later because of lack of funds he was transferred to the Cook County Hospital. At the Cook County Hospital the infection was treated and the wound healed leaving however fixation contracture of the elbow with a dense scar across the anterior and medial surface of the arm just below the elbow. He was then seen by Dr. Sumner L. Koch who diagnosed a division of the median and ulnar nerves and biceps tendon. The scar of the infection however was too dense and contracted to permit repair. Dr. Koch therefore excised this scar and applied a pedunculated flap of skin taken from the abdominal wall (Fig. 96). Following discharge from the Cook County Hospital the patient transferred to Northwestern University Dispensary and Passavant Memorial Hospital. On November 11, 1936, eleven months after the injury the flap was raised along its medial border and the antecubital fossa explored. The proximal end of the median nerve bearing a large neuroma

left palm due to a rope burn sustained eight months previously. Examination (Fig. 95 a) showed a marked contracture of the left palm due to a thick scar extending from the web space between the thumb and index finger across the palm in the region of the metacarpophalangeal joints to the base of the little finger. Dense bands extended distally onto the volar surfaces of the middle, ring and little fingers holding them in rigid flexion and forming a thick web between the middle and ring fingers. At operation the entire contracted tissue was dissected away, the fingers were extended and a full thickness graft cut to an exact pattern was sutured into the defect. The hand was fastened to an aluminum splint which held the fingers in complete abduction and extension.

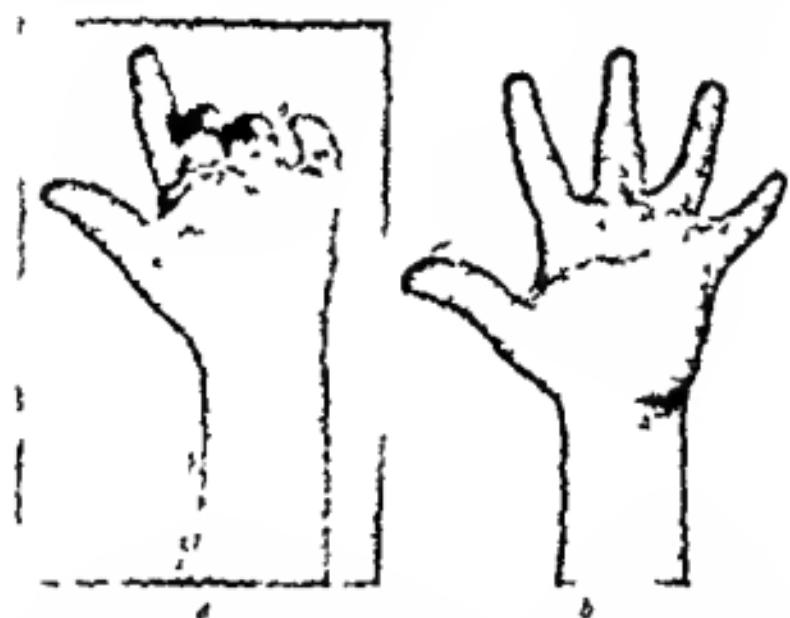


Fig. 95—Case III. Flexion contracture due to rope burn eight months previously. *a* Condition before excision and free full thickness skin graft. *b* Two and one half months after operation.

and the thumb in abduction and rotation and a pressure dressing applied. Satisfactory healing occurred with the result shown in Fig. 95 *b* which shows the boy able to extend all the digits completely. There is however still slight webbing between the fourth and fifth fingers which will possibly need correction later.

It is of course unnecessary to say that the excision of the scar must be done in a bloodless field so as to avoid injury to nerves and blood vessels. If the operation can be done early enough there will be found to be very little difficulty in straightening the fingers completely and certainly the nerves and blood vessels are rarely the tissues at fault. If complete

subcutaneous vessels was well circumscribed by a capsule and there were no large vessels connecting it with the digital vessels beneath. The angioma and the overlying skin were excised "en bloc" and the resultant defect replaced by a free full thickness skin graft.



Fig. 97.—Case V. Hemangioma of the palm. *a* and *b* Before operation *a* photograph with ordinary light and *b* with infra-red light. *c* after excision of the tumor and skin and replacement with free full thickness graft.

In this case the essential operation was the removal of a vascular tumor intimately associated with the palmar skin. The excision of the tumor was impossible without sacrificing some skin and this defect was immediately repaired by a free full thickness graft taken from the forearm. Similar but more extensive removal of involved skin must be done in the management of roentgen dermatitis of the hand in which much if not all of the skin on the dorsum of the hands and fingers is actually or potentially involved.

was found fairly easily in the arm. The distal end however, was located with difficulty, densely adherent to the scar in the antecubital fossa. When these two ends were found it was seen that they were too far separated to admit end-to-end suture. Consequently the elbow was flexed and the neuromas were sutured together with silk. The ulnar nerve was not sought at this time. A cast was applied the wound allowed to heal and at the end of three weeks the patient allowed gradually to extend the elbow. Two months later the flap was again raised and the stumps of median nerve were found to be fused and to have lengthened sufficiently to allow end-to-end suture. The ulnar nerve ends were located and after isolation and excision of neuromas were transferred to a position anterior to the medial epicondyle and an end-to-end suture performed.

This case illustrates the need for a skin flap preparatory to nerve suture, a situation not infrequently encountered following crushing injuries and infections in which not only are the nerves and tendons divided but there is considerable destruction of skin. It would be of course hopeless to attempt repair under the thick contracted scar with its covering of thin avascular skin. In the absence of subcutaneous tissues the repaired structures immediately become adherent, and the thin skin sutured under tension undergoes necrosis and infection. Here we must first provide a flap of good skin and subcutaneous tissue before deeper repair can be attempted. It is my preference to raise such flaps in stages before applying them. By judicious raising and undercutting in several stages we can secure a flap in almost any desired location and with a pedicle in any direction. We are also able to obtain thinner flaps than if we raise them in one stage only and we can obtain flaps of almost any desired size since we can progressively enlarge the flap even after it has been transferred.

Case V—(Passavant Memorial Hospital No 36891) D R a switchman seventy three years old was admitted to Passavant Memorial Hospital from the Northwestern University Clinics for treatment of a vascular tumor of the left palm. The mass was first noted eight years previously as a small nodule which he had been told to massage. The mass slowly enlarged and three years later he visited a clinic where an incision was made and so much bleeding encountered that nothing further was done after hemostasis had been accomplished. Since that time the tumor increased to three times its original size and became painful. Examination (Fig 97) showed a soft purple hemispherical mass about 1 inch in diameter in the palm over the fourth and fifth metacarpals. It did not pulsate but could be reduced in size by pressure and elevation. Diagnosis was made of vascular tumor probably cavernous hemangioma of the palm. At operation the angiomatous mass was found to arise from the

phalangeal joints. The plantar fascia occasionally shows similar contraction. Subjective symptoms are few but functional disturbances are progressive and often severe.

The preferred treatment is a complete excision of the palmar fascia of all the involved digital fascia and of all hopelessly involved skin followed by immediate closure without tension either by suture or skin graft. Because of the intimate association of the digital nerves and vessels with



Fig. 98. Incisions used in removal of palmar fascia in Dupuytren's contracture. Incisions should not be in the midline of the fingers and should not cross flexion creases transversely.

the deep palmar prolongations of the fascia and the digital sheets of the fascia great care must be used in making the excision lest these structures be damaged. The incisions for the operation should be so planned as to avoid crossing flexion creases transversely and should never be in the midline of the fingers. The ones illustrated in Fig. 98 have given good access and heal with a minimum of functional disturbance. Incisions are made on the fingers only if the digital fascia is

DUPUYTREN'S CONTRACTURE

Dupuytren's contracture is a disease of the palmar fascia in which this structure becomes thickened and contracted and in so doing draws the fingers into flexion at the metacarpophalangeal and proximal interphalangeal joints and causes dimpling and contraction of the palmar skin. The pathologic process consists essentially of hypertrophy and contraction of the fascia, with thinning and fibrous contraction of the overlying skin. Little is known as to its actual cause. It is more frequent in males than in females, is more often bilateral than unilateral and affects persons in all occupations. It does not appear that manual labor predisposes to its development and while it is most often seen in the fifth and sixth decades it is not rare under forty and has been observed in children.

Numerous theories have been advanced to account for the disease none of which appears to be universally applicable. It has been ascribed to trauma, usually chronic though occasionally acute, but its tendency to become bilateral and symmetrical and to occur with greater frequency in persons not doing manual labor than in those so engaged speaks strongly against it. Some toxic agent, such as might be present in gout, "rheumatism" and tonsillar sepsis has been advanced by many, but actual proof is lacking. The neurogenic theory has its adherents. There is a marked tendency for the disease

opinion that this is the most important single etiologic factor.

The clinical features of the disease are characteristic and unmistakable. The contracture begins as a hard fibrous nodule in the palm at the distal palmar crease usually at the base of the ring or little finger. While the nodule may remain stationary for many years the disease usually progresses slowly so that within a few months or a year cords develop in the palm and over the volar surfaces of the proximal phalanges of the ring and little fingers. These cords draw the affected finger into flexion. Other fingers may be affected the index and thumb however quite rarely. Fibrous pads may occur over the dorsal surfaces of the proximal and distal inter-

the wrist and distally toward the base of the little finger. Three years later, in 1934 a nodule developed on the flexor surface of the proximal phalanx of the ring finger and this nodule slowly enlarged and became incorporated in a fibrous band which extended from the palm to the finger. A third thick fibrous nodule appeared over the proximal interphalangeal joint of the little finger in 1936. With the development of these nodules and the fibrous cord which connected them the little finger became fixed to almost 90 degrees at the proximal interphalangeal joint, less at the metacarpophalangeal joint. The metacarpophalangeal joint of the ring finger was moderately flexed largely because of the

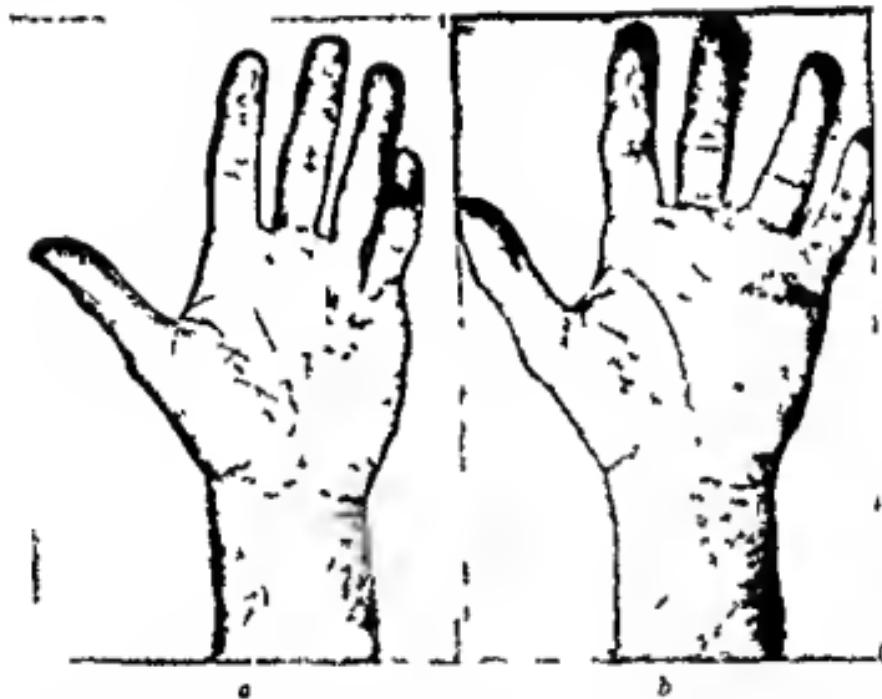


Fig 100—Case VI. Dupuytren's contracture. *a* Left hand before operation *b* nine months after operation. The free full thickness graft is still darker than the surrounding skin

pull of the fifth finger upon it but also because of slight shortening of the

an

his 10000 he had marked dental caries and was an inveterate tobacco chewer. He had one brother with bilateral Dupuytren's contracture another brother with contracture of the right hand and a grandmother had flexion deformities of the fingers. He thought however his grandmother's condition may have been arthrosis.

The right hand was operated upon in March 1933 through a palmar L-shaped incision which followed the distal palmar crease to the radial border of the hypothenar eminence and thence upward over the eminence toward the

involved. A bloodless field as repeatedly emphasized by Kanavel, Koch, Bunnell and others who have done considerable plastic surgery of the hand is essential to the necessarily painstaking dissection.

Case VI—(Passavant Memorial Hospital Nos 13358 25365) A G. S., a piano tuner fifty years of age was admitted to Passavant Hospital in March 1933 because of flexion contracture of the little fingers of both hands. The contracture had begun as a small hard nodule over the region of the metacar-

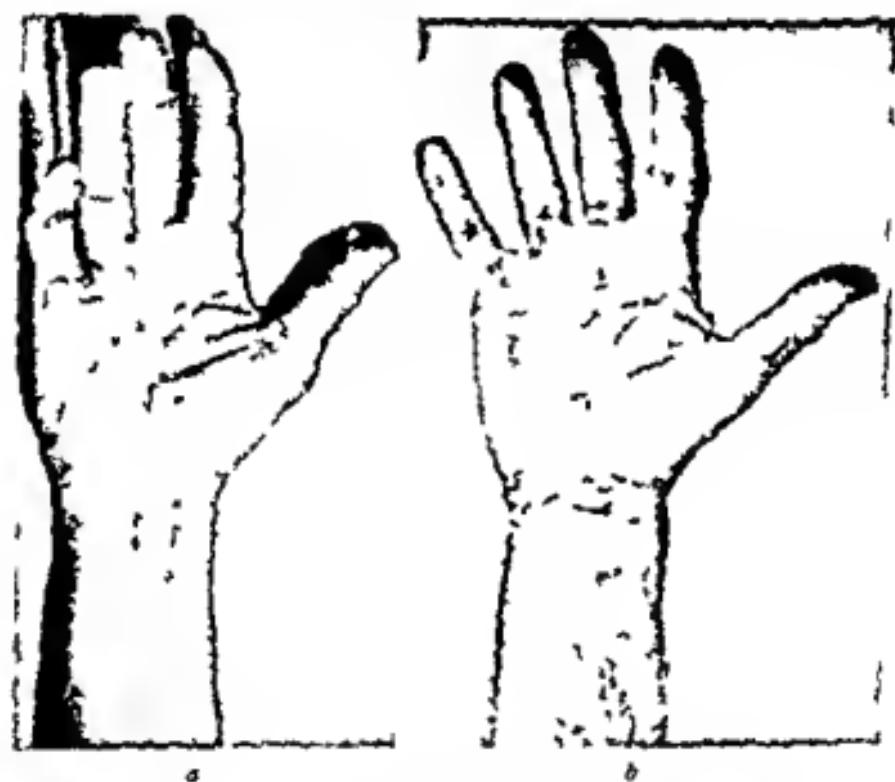


Fig. 99—Case VI. Dupuytren's contracture. *a* Right hand before operation
b after operation

pophalangeal joint of the little finger of the right hand in 1930. This nodule had slowly enlarged and hard cords had appeared which extended from the nodule proximally toward the wrist and distally toward the bases of the ring and little fingers. As time progressed the cords gradually thickened and contracted so as to produce a flexion deformity (Fig. 99 *a*) of the little finger and to less extent of the ring finger. The flexion was most marked at the proximal interphalangeal joints of the little finger. The contraction in the left hand (Fig. 100 *a*) began in 1931 as a hard nodule in the base of the palm along the radial side of the hypothenar eminence. This nodule gradually enlarged and a fibrous band appeared which extended from it proximally toward

the wrist and distally toward the base of the little finger. Three years later in 1934 a nodule developed on the flexor surface of the proximal phalanx of the ring finger and this nodule slowly enlarged and became incorporated in a fibrous band which extended from the palm to the finger. A third thick fibrous nodule appeared over the proximal interphalangeal joint of the little finger in 1936. With the development of these nodules and the fibrous cord which connected them the little finger became flexed to almost 90 degrees at the proximal interphalangeal joint less at the metacarpophalangeal joint. The metacarpophalangeal joint of the ring finger was moderately flexed largely because of the

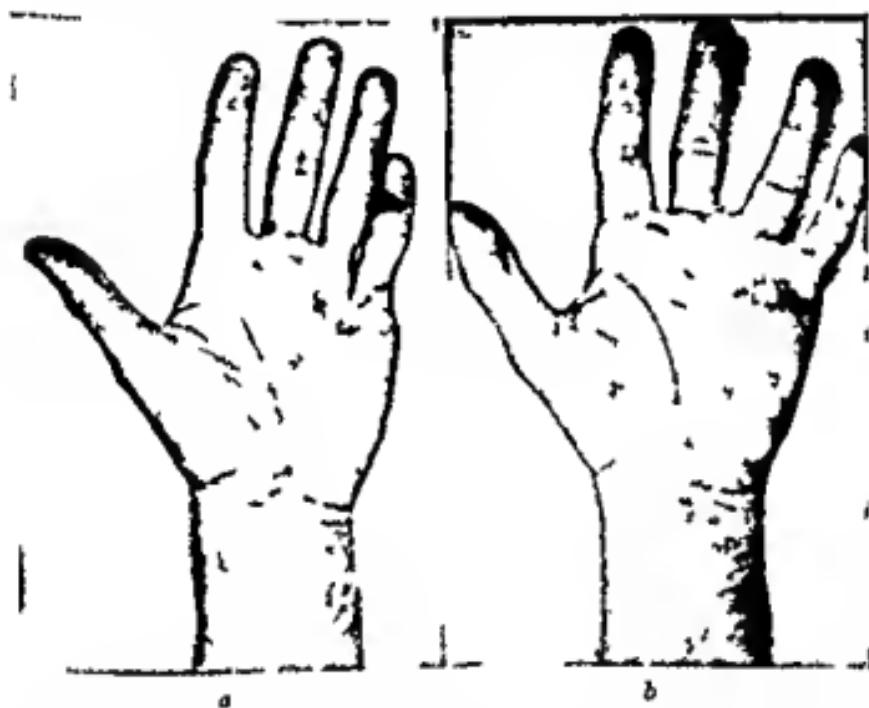


Fig 100—Case VI. Dupuytren's contracture. *a* Left hand before operation. *b* nine months after operation. The free full thickness graft is still darker than the surrounding skin.

pull of the fifth finger upon it but also because of slight shortening of the metacarpal ligaments in the web space.

The patient was a piano tuner and had used a tuning hammer all his life and carried a heavy tool case. He did not believe that this was the cause of his trouble. He had marked dental caries and was an inveterate tobacco chewer. He had one brother with bilateral Dupuytren's contracture, another brother with contracture of the right hand and a grandmother had flexion deformities of the fingers. He thought however his grandmother's condition may have been arthritis.

The right hand was operated upon in March 1933 through a palmar L-shaped incision which followed the distal palmar crease to the radial border of the hypothenar eminence and thence upward over the eminence toward the

wrist. An accessory L-shaped incision was made on the little finger and another on the ring finger to remove the digital fascia. The digital nerves and vessels in the web space between the ring and little fingers were considerably distorted by the contracted fascia so that constant visualisation and anatomic dissection were necessary to avoid injury to them. The incisions were closed without the necessity of a skin graft. The final result of the operation on this hand is shown in Fig. 99 *b*, which was taken four years later.

The operation on the left hand was performed on March 1935. There was found marked thickening of the pretendinous bands from the region of the transverse carpal ligament down to the region of the metacarpophalangeal joints of the ring and little fingers. From here the band extended distally over the volar surface of the little finger as far as the distal interphalangeal joint. An incision was made along the ulnar side of the little finger from the region of the distal interphalangeal joint proximally to the distal flexion crease of the palm, then transversely to the middle of the palm and proximally along the central longitudinal crease of the palm to the wrist. The palmar fascia and the contracted band on the volar surface of the little finger were removed. When the little finger was straightened a defect was present in the palm about 1 inch wide and 1 $\frac{1}{2}$ inches long. This defect was closed with a free full thickness graft taken from the volar surface of the forearm. The hand was dressed on a splint with sea sponge pressure. The result of this operation is shown in Fig. 100 *b* taken nine months later and shows the graft still of slightly darker color than the surrounding skin.

SECONDARY TENDON REPAIR

I should like now to show 2 cases of secondary tendon repair. It is of course impossible to discuss this extensively at this time, but the cases selected illustrate a number of the problems met with in this type of surgery.

Case VII—(Passavant Memorial Hospital No. 35634) W. B., a rail road employee twenty two years of age was seen because of inability to extend the distal phalanx of the right ring finger. Two weeks previously while pulling meat in the baggage department a box slipped and his right ring finger was caught between two holes in such a way as to produce sudden acute flexion and he subsequently noticed that he was unable to extend the distal phalanx. Examination showed the typical deformity (Fig. 101 *a* and *b*) of extensor tendon rupture (baseball finger) of the right finger. The distal phalanx could be flexed but extension was weak and the joint could not be brought beyond an angle of 145 degrees. An x-ray examination showed no bony damage. The finger was operated upon March 7, 1938 through an L-shaped incision one limb of which crossed the flexion crease of the distal interphalangeal joint, the other lay along the ulnar side of the middle phalanx. The extensor tendon was found to have ruptured at the level of the interphalangeal joint, the joint capsule was ruptured and bits of capsular membrane had fallen into the joint cavity. The tendon ends and joint capsule were found to have united in a

lengthened position through a thin scar. The scar was divided and the capsular tags removed from the joint space. The distal phalanx was then brought



Fig. 101.—Case VII. Rupture of extensor insertion at the base of distal phalanx of ring finger. *a* Before repair. *b* After repair.

into extension which allowed the tendon ends and joint capsule to be brought together with a slight overlap where they were held with 3 fine silk mattress type sutures. The skin was closed with a few fine silk subcutaneous sutures

and horsehair. The finger was splinted in hyperextension for a period of five weeks at which time the splint was removed and the patient allowed full use of the hand (Fig. 101 *b*).

Dropped finger tip or baseball finger is a not unusual condition about which a great deal has been written. It is due to one of two things, either a rupture of the extensor tendon at or near its insertion into the base of the distal phalanx or to an avulsion of the shell of bone of the distal phalanx into which the tendon inserts. It is important therefore to obtain a lateral x-ray film of the finger to determine if such a fracture be present, for if it is the condition should be treated by splinting the distal phalanx in hyperextension for five to six weeks. If no such fracture is present we know that the tendon itself has ruptured. There are two opinions as to the correct management of the tendon rupture. Many surgeons contend that if the finger is kept in hyperextension at the distal joint for five or six weeks spontaneous union in good position takes place. It is unquestionably true that the extensor tendons if injured over that part of their course where they are surrounded by paratenon instead of synovial sheath will heal spontaneously and that if they are kept relaxed during healing the resultant tendon will be of good length and functional. This spontaneous repair we have observed many times in the case of open division of the extensor tendons in patients whom we have seen too late to warrant open repair. However it is my feeling that the situation is different in the case of rupture at the distal phalanx since here the joint capsule has torn through and bits of tissue from it fall into the joint space. These bits of tissue prevent complete extension of the joint and act as an irritant and should be removed.

Case VIII.—(Passavant Memorial Hospital No. 34057) F. H., a farmer, thirty three years of age, was admitted to Passavant Hospital November 7, 1937 for repair of hatchet injuries received to his right and left forearms two months previously. The wounds had been taken care of elsewhere and had healed without reaction. The right forearm and hand the only one which has so far been repaired showed a transverse laceration about $2\frac{1}{2}$ inches long.

done at the lower wound and that the injury was due to tend to division and not to division of the radial nerve since extension of the wrist and little finger was still present. At operation the original wound was reopened and extended distally from its radial end and proximally from the ulnar end so as to produce two large flaps. The extensor digitorum communis tendons were first sought distally at the wrist and traced proximalward to the scar out of which they were then dissected. The extensor pollicis longus was next isolated proximally and traced upward to the scar and was found to have been divided through its muscular portion. After the distal stumps had been isolated the proximal ends were found well above the site of injury and traced downward to it. The distal stump of the extensor pollicis longus was approximated to its muscle without



Fig. 102—Case VIII. Division of extensor pollicis longus, extensor digitorum communis to index, middle and ring fingers and extensor indicis proprius. *a* and *b* Before repair. *c* and *d* after tendon graft of extensor communis and suture of extensor pollicis longus.

undue tension. It was impossible however to approximate the extensor tendons to the index, middle and ring fingers. Therefore three tendons were removed from the dorsum of the right foot and inserted as grafts one to each of the three fingers. Fat and areolar tissue were placed between the various repaired tendons and the wound closed. A volar splint was used to keep the fingers in extension and the thumb in extension and abduction. Healing took place without reaction and the splint was discarded at the end of five weeks. The patient was last examined six months after the injury (Fig. 102 *c* and *d*). He has complete extension of the thumb and fingers is working as a farm laborer and complains of no disability in this hand.

We might discuss at this point a few of the important considerations of secondary tendon repair of the hand. The length of time we must wait after the original injury before

and horsehair. The finger was splinted in hyperextension for a period of five weeks at which time the splint was removed and the patient allowed full use of the hand (Fig. 103 b).

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incision in a better location. If the original wound is reopened it must be so extended as to gain access to normal tissues well above and below the site of the injury. The search for the tendon ends should be started in normal tissue the tendons found and traced downward and upward to the site of injury. It is hopeless and unwise to search in the scar since here all structures are fused and indistinguishable. Considerable damage may be done by attempting to find tendon stumps in the scar tissue. If however, we find the tendons above and below they may be traced to the scar and our task still not an easy one is not so great. After the tendons have been isolated it may be necessary to free them from adhesions along their course after which we must decide on the manner in which we should make the repair. We may suture them end to end we may put in a tendon graft we may perform a tendon transference. It would unduly prolong the discussion to enlarge upon the various factors upon which our decisions are made. In general end to end suture is preferable if we can perform it in such a way that the suture line lies in fatty or areolar tissue and providing of course that the tendon ends can be brought into apposition. If end to end apposition is not possible a graft is needed and here we may obtain material from the long extensors of the toes or occasionally from the palmaris longus tendon. When we are attempting secondary repair within the osteofibrous tunnel on the volar surfaces of the fingers it has seemed best to remove the stumps from the fingers and replace them with a smooth tendon graft so that no suture line lies within the tunnel. The type of suture and suture material I believe to be important. Tendon is poorly vascularized and we should be careful that the sutures introduced into it should be fine and should disrupt its structure as little as possible. While we depend to a large extent upon circulation from surrounding tissues we must not disrupt or irritate the living tendon with coarse irritant sutures. Silk in the finer grades should be used. Catgut in my opinion is much too irritant and too large for this purpose. The Max Lange method of tendon suture which we have slightly modified has seemed to us to be the best so far devised. In this suture the ends of the tendon are not loaded with silk but are left comparatively free. A

secondary repair can be undertaken depends in general upon the manner of healing of the original wound, upon the condition of the surrounding tissues and upon the mobility of the joints activated by the divided tendons. If the original *incision* was closed promptly and healing secured without reaction secondary repair can be safely attempted within three to six weeks. If, however, an infection has developed a longer delay is necessary since we must be reasonably sure that there is no residuum of infection in the wound. In cases in which the inflammatory reaction has been minimal, possibly a mild staphylococcal infection which subsided within a week or ten days we may usually reopen the wound within six to eight months after the infection has subsided. If, however, a severe infection has been present, with marked general reaction and long period of sepsis we must delay for at least a year, often eighteen months after the inflammation has completely subsided.

The tissues in the field of operation must be soft and pliable before we should reopen them to perform secondary repair. Since induration and fusion of structures are usually indicative of an inflammation the period of time we wait for inflammation to subside usually suffices to obtain softening of the areas of induration. If the skin over the site of repair is thin, scarred poorly vascularized and contracted we must replace it with normal skin before attempting our repair.

The joints which are moved by the divided tendons must be freely movable before the tendons are repaired since we cannot hope to obtain a functioning tendon if the joints are stiff. Therefore while awaiting the time to perform secondary repair the fingers and wrist should be kept freely moving. If they have been allowed to ankylose we must institute measures to free them. Here a competent physical therapist and tension splinting are of great value.

We have discussed on several previous occasions the actual technic of tendon repair. Briefly the repair should be done in a bloodless field which may be obtained by means of a blood pressure apparatus pumped up to 250 or 260 mm. Hg after the skin is stretched for twenty to thirty seconds. We wound, it is some take the operative

CLINIC OF DR. WILLIAM B. SIRBIN
WESLEY MEMORIAL HOSPITAL

BREECH PRESENTATION

Frequency—From various clinics over a long period breech presentation has varied from 2.5 to 4.6 per cent of all presentations. Our incidence at Wesley Hospital for the last six years has varied from 2.7 to 4.6 per cent thus giving an average incidence of 3.3 per cent. This average has been the general consensus of opinion and has not varied much in the last twenty years. This error of presentation occurred about three times more frequently in multiparae than in primiparae in our series.

Diagnosis During Pregnancy—There is perhaps one symptom quite characteristic of breech presentation. Many patients complain of a tender mass high in the abdomen or under the ribs. On palpation this round tumor proves to be the head all other findings are objective. On inspection the long axis of the fetus is longitudinal on palpation the fetal head is in the fundus of the uterus. It is firm quite round ballotable and mobile on the trunk. The breech is over the inlet is slightly irregular and not ballotable. On auscultation the fetal heart tones (F H T) are best heard above the umbilicus this is so because the fetal chest is located well above this landmark. To be appreciable for abdominal diagnosis the pregnancy should be at least of twenty four to twenty six weeks duration. From the twenty sixth to the thirty fourth weeks they should be more easily heard and from that time to term both the palpatory and auscultatory findings are easily and more clearly discernible.

Occasionally rectal examination may be helpful although with the breech high the cervix closed and the membranes intact this may be difficult. If the diagnosis is still uncertain

tension suture is introduced into each tendon stump about 1.5 to 2 cm from the site of division. The needle first picks up a few fibers on the outer border of the tendon and the silk is knotted about them. The needle is then passed straight through the tendon and a similar small group of tendon fibers picked up on the opposite side. These sutures are then tied together approximating the ends of the stumps and accurate apposition is maintained by a few very fine silk sutures (arterial 6-0 silk on atraumatic needles) which pass only through the peritoneum externum.

Effort should be made after tendon repair has been accomplished to obtain layers of fat or areolar tissue between adjacent sutured tendons and between sutured tendons and surrounding tissues. We may often obtain such fat locally from the subcutaneous tissues of the forearm. If this is not possible we may obtain as much as is needed from the abdominal wall.

Postoperative care is important. The hand is dressed with a pressure dressing which is applied before final release of the blood pressure cuff. This pressure dressing which should not be disturbed for two to four days controls the oozing which is sure to occur after operation. The hand must be splinted in the position of relaxation of the sutured tendons and this relaxed position should be maintained for three weeks in the case of the flexor tendons and for five weeks in the case of the extensor tendons. The longer period of immobilization of the extensor tendons is necessary because the stronger flexors tend to stretch the tendon callus. Active motion in the splint may be instituted on the third or fourth day and physical therapy consisting of heat and gentle massage may be started as soon as the wound has healed. During these procedures however the splint must be kept on and the relaxation maintained.

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by combined abdominal and rectal examinations, x ray diagnosis is of great value

Diagnosis During Labor—By abdominal palpation auscultation and rectal examination, as described above. If the cervix is closed, the membranes intact and the breech high a careful vaginal examination may be made. If this is done, the pelvis should be carefully judged as to its size, the relationship of the breech to it, the type of breech, and, where possible, the differential diagnosis from a face presentation (This latter can be done only when there is sufficient cervical dilatation, and only if the membranes are ruptured.) The buttocks, sacrum or feet can be palpated in the case of a breech, the facial features, jaws and gingival margins in the face presentation. It is important also to remember that the diagnosis of breech presentation is frequently missed during pregnancy and even labor because we do not ordinarily think of it 96 per cent of all presentations being cephalic. Sometimes we are caught unawares only to find a breech late in labor. It is necessary therefore to examine every patient at the onset of labor and always to bear breech presentation in mind, as the conduct of labor especially during the second stage, is very different from that in cephalic presentation. Forceps have been applied to the breech in total ignorance of its presence, the assumption being that a cephalic presentation was being dealt with. It may be necessary to resort to x ray examination even during labor in cases of uncertainty.

Types of Breech Presentation—Breech presentations may be divided into the complete and incomplete subtypes. There is only one complete breech presentation all the others are incomplete. The first or complete type is one in which the fetus lies in an attitude of flexion the head is flexed toward the chest, the thighs toward the abdomen the legs toward the thighs and the arms and forearms lie across the chest. In this attitude the buttocks and feet may lie in contact with the os, a larger circumference of the fetus presents at the cervix and hence this is the most favorable type of breech presentation.

The other types, all incomplete are frank breech single footling and double footling. Occasionally a knee may appear at the cervix or in the vagina but this is essentially a footling

In the frank breech variety, both buttocks present at the inlet, the thighs are flexed on the abdomen and the legs are extended on the thighs. This type is fairly common and often associated with great difficulty during labor. In single footling one leg may protrude through a partially dilated cervix or appear at the vulva and the other leg may be partially or completely extended. The 'kneeling' varieties occur very rarely, one or both knees may present.

Complications—These are of three varieties either mechanical because of the breech *per se*, medical (toxemia, cardiac disease etc) or of a surgical obstetrical nature, with placenta praevia or ablatio placentae.

The mechanical complications due to the breech itself are contracted pelvis possibly with frank breech the extended legs acting as splints against the body, thus preventing descent, prolapse of the cord because the breech does not fit the pelvic inlet perfectly prolapse of a foot through an incompletely dilated cervix the member becoming constricted, edematous and cyanotic. Twins may also give mechanical difficulty.

The complications of a medical nature may be the same as those with any other type of presentation, viz., toxemia, cardiac disease etc and would call for the same type of treatment required for these complications with the mechanical factors in the background.

The surgical obstetrical complications are likewise similar to the medical in that they can also occur with other presentations viz., placenta praevia and ablatio placentae, and call for special management along these lines. In a multipara with placenta praevia breech might be an added advantage, inasmuch as it would obviate the necessity of a Braxton Hicks version.

Mechanism of Labor—Six positions of the breech are recognized viz sacrum left anterior (S L A) sacrum right anterior (S R A) sacrum right posterior (S R P), sacrum left posterior (S L P) and two transverse varieties—sacrum left transverse (S L T) and sacrum right transverse (S R T). The two latter are intermediate and transitory and not often referred to although delayed labor in breech presentation may be due to one of these positions.

by combined abdominal and rectal examinations x-ray diagnosis is of great value

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upward a cent and deliver first over the perineum. This movement corresponds to extension in a cephalic presentation. Then the anterior hip disengages from underneath the symphysis and delivers last. This would be the mechanism if allowed to deliver without aid. At this point manual aid changes the mechanism slightly. The pelvic floor rotates the trunk anteriorly in 95 per cent of the cases. In about 5 per cent the trunk is rotated posteriorly. This movement is external anterior rotation and it normally takes place (in S L A) from left to the midline or beyond and finally with complete descent and external anterior rotation of the trunk the shoulders are brought into relation with the inlet.

Mechanism of the Shoulders—The bisacromial diameter engages in the left oblique diameter of the inlet. The anterior or left shoulder is at the right iliopectineal eminences and with descent is rotated through an arc of 45 degrees from right to the midline. The anterior shoulder then impinges under the symphysis and the posterior shoulder is (theoretically) delivered first. Manual aid must be rendered here to free the arms and the order of their delivery is sometimes reversed: e. anterior shoulder first and posterior shoulder last. After the shoulders and arms have been delivered the aftercoming head is brought into relation with the inlet of the pelvis.

Mechanism of the After coming Head—The head presents at the pelvic inlet neck end first and vertex last, i. e. in reverse order from what occurs in forecoming head in vertex presentations. The suboccipitobregmatic diameter engages in the right oblique diameter of the inlet. The occiput then is in the left anterior quadrant of the pelvis. Internal anterior rotation is from left through an arc of 45 degrees to the midline. The occiput then impinges under the symphysis as a fulcrum and the head delivers or is delivered in an attitude of flexion.

Mechanism in S R P—Sacrum in right and posterior quadrant of pelvis. Bisiliac diameter engages in left oblique diameter of inlet anterior hip at right iliopectineal eminence internal anterior rotation from right to midline through an arc of 45 degrees. Anterior hip impinges under symphysis trunk delivered to shoulders. Bisacromial diameter engages in left

In S L A the sacrum is in the left and anterior quadrant of the pelvis, the fetal back to the left and anterior part of the uterus and the occiput in the left and anterior part of the fundus. The F H T are about 3 cm above and to the left of the umbilicus.

In S R P the sacrum is in the right and posterior quadrant of the pelvis, the fetal back to the right and posterior part of the uterus, the occiput in the right and posterior part of the fundus and the F H T are best heard in the right and posterior part of the abdomen on a level above the umbilicus.

In the two lateral positions the sacrum back and occiput are on the right or left sides respectively, the small parts on the opposite side and the F H T best heard on the side corresponding to the back. The sacrum is the part of designation and the anterior hip the point of direction irrespective of the type of breech.

The mechanism of labor conforms to the general principles, viz engagement descent flexion internal rotation extension restitution and external rotation. Further there are three mechanisms to be considered that of the hips (pelvic girdle) shoulders (shoulder girdle including the arms) and the mechanism of the after coming head. Given a normal sized full term baby and a normal position S L A the mechanism of labor may be described as follows. Sacrum in left anterior quadrant. The brachial diameter of the baby engages in the left oblique diameter of the inlet of the pelvis. The left or anterior hip is toward the right iliopectineal eminence of the maternal pelvis. Under the influence of strong labor pains the breech descends into the cavity of the pelvis and when it encounters the resistance of the pelvic floor the anterior hip is rotated anteriorly through an arc of 45 degrees from the right iliopectineal eminence to the inferior angle of the symphysis pubis. The anterior hip then impinges underneath the symphysis and the posterior hip is brought upward along the vaginal floor to the perineum. The trunk of the baby then undergoes a combined lateroflexion and internal anterior rotation. Remember in breech presentation internal rotation of the hip is from the opposite side of the pelvis to the midline, i.e. in S L A from right toward the symphysis. The posterior hip and buttock then make an

upward ascent and deliver first over the perineum. This movement corresponds to extension in a cephalic presentation. Then the anterior hip disengages from underneath the symphysis and delivers last. This would be the mechanism if allowed to deliver without aid, at this point manual aid changes the mechanism slightly. The pelvic floor rotates the trunk anteriorly in 95 per cent of the cases, in about 5 per cent the trunk is rotated posteriorly. This movement is external anterior rotation and it normally takes place (in S L A) from left to the midline or beyond and finally with complete descent and external anterior rotation of the trunk the shoulders are brought into relation with the inlet.

Mechanism of the Shoulders—The bisacromial diameter engages in the left oblique diameter of the inlet, the anterior or left shoulder is at the right iliopectineal eminences and with descent is rotated through an arc of 45 degrees from right to the midline. The anterior shoulder then impinges under the symphysis and the posterior shoulder is (theoretically) delivered first. Manual aid must be rendered here to free the arms and the order of their delivery is sometimes reversed; i.e., anterior shoulder first and posterior shoulder last. After the shoulders and arms have been delivered the aftercoming head is brought into relation with the inlet of the pelvis.

Mechanism of the After coming Head—The head presents at the pelvic inlet neck end first and vertex last, i.e., in reverse order from what occurs in forecoming head in vertex presentations. The suboccipitobregmatic diameter engages in the right oblique diameter of the inlet. The occiput then is in the left anterior quadrant of the pelvis. Internal anterior rotation is from left through an arc of 45 degrees to the midline. The occiput then impinges under the symphysis as a fulcrum and the head delivers or is delivered in an attitude of flexion.

Mechanism in S R P—Sacrum in right and posterior quadrant of pelvis. Bisiliac diameter engages in left oblique diameter of inlet anterior hip at right iliopectineal eminence, internal anterior rotation from right to midline through an arc of 45 degrees anterior hip impinges under symphysis, trunk delivered to shoulders. Bisacromial diameter engages in left

oblique of inlet anterior shoulder rotated from right to mid line. The after-coming head suboccipitobregmatic diameter engages in right oblique diameter of inlet rotates through an arc of 135 degrees from the right sacro-iliac synchondrosis to the midline occiput impinges under the symphysis and the head is born in flexion.

The two transverse varieties right and left sacral respectively become anterior or posterior and terminate according to either mechanism as described above. Occasionally there may be failure of these to engage or rotate. These constitute high arrest of the breech and will be dealt with under management.

The mechanisms briefly described above are theoretical there are many exceptions as e.g. with descent and rotation breeches as a rule do not terminate as easily and spontaneously as cephalic presentations. They do not deliver themselves but rather have to be delivered by manual aid or application of forceps to the aftercoming head. This brings us to the management of breech presentation.

Management During Pregnancy—Inasmuch as breech presentations in early pregnancy occur more frequently than the average quoted statistics indicate some effort might be made to correct this potentially pathologic presentation. Before the twenty-eighth week of pregnancy they need cause no great alarm some undergo spontaneous version and correct themselves. From the twenty-eighth to the thirty-sixth weeks of pregnancy spontaneous version is still possible but less likely. After thirty six weeks and until term the breech usually maintains itself as such in some rare instances the breech has undergone spontaneous version as late as the first stage of labor. Two courses of action are now open. The original breech presentation may be allowed to continue or an external version may be done.

The indication for external version is of course the primary breech presentation. The conditions are sufficient liquor amnii and sufficient space in utero related uterine and abdominal walls the baby must turn easily and a knowledge of the technic.

Technic of External Version—The patient should be placed on a high examining table her shoulders should be

slightly lower than her hips, the operator's hands should be warm to prevent abdominal or uterine contraction. Anesthesia is not necessary. The operator lifts the breech from the pelvic inlet and brings it into an iliac fossa with the lower hand, and with the other hand he maintains the head in flexion and moves it in the opposite direction. The direction of version should be toward the side containing the back and occiput of the fetus, slow alternate movements are made on the fetal poles. If great resistance is encountered, the attempt should be discontinued, most external versions can be successfully executed. After the operation is completed, the new position should be checked, the F H T taken and the patient allowed to rest for about thirty minutes. Binders and pads are necessary, the new position will usually maintain itself without these. If the version fails either of accomplishment or in maintaining itself, it may be attempted at a later date.

If possible, the new cephalic position should be one of maintained flexion and for that reason the direction of turning should be toward the fetal back and occiput with the head maintained in flexion. If this is not possible, turning in the opposite direction may be necessary, although the head may remain in an attitude of deflexion.

Contraindications and Objections to Prophylactic External Version—The operation should be discontinued if great resistance is encountered because there may be a septum in utero, a short cord or a loop of cord tight around the baby's neck may be further tightened a traumatic separation of the placenta might occur. These are theoretical objections, they can occur but they are rare. The maneuver should not be attempted in cases of twins or during labor.

I regard prophylactic external version a useful procedure in breech presentation and now employ it in all such patients from the twenty eighth to the thirty sixth week. I have had only a few failures, either in turning or in maintaining the new position and in some of these latter have repeated the procedure with success.

Management During Labor.—The attendant's skill is put to a severe test in his management of breech presentation. Intelligent and skilled conservatism, sometimes erroneously

called watchful expectancy should prevail and preparations for any contingency should be at hand. The most ideal termination is spontaneous delivery through the maternal passages. Conduct of labor will vary with such circumstances as environment, age, parity, type of pelvis, size of baby, normal or deformed baby, twin pregnancy, condition of membranes whether intact, recently ruptured or ruptured many hours. Other complications might be placenta praevia, ablatio placentae or toxemia of pregnancy.

First Stage—In the main the course should be conservative. Dilatation may be slow, mechanism of the breech may be delayed. If unusually prolonged a sedative may be given especially to primiparae. Morphine sulfate seems to be best, the barbiturates are not so satisfactory because of their prolonged depression and later when the patient's cooperation is desired she may be unable to give it. The patient is not encouraged to walk around in fact is better off her feet. This helps to preserve the membranes and to prevent prolapse of the cord. Breech labors are not unusually prolonged. It is stated that the breech is a poor dilator but the presenting part alone does not dilate the cervix. The F H T should be taken at regular half hour intervals. Liquids may be given.

Second Stage—The patient should be told that she has a breech presentation and her cooperation should be enlisted. She may aid greatly in bringing the breech down. Analgesia may be given during the pains, ether or gas oxygen may be used. For breech presentation spontaneous delivery may be defined as follows. Descent of the breech to the perineum by the patient's own expulsive effort, the giving of manual aid to the legs, hips, shoulder girdle and arms, and the delivery of the after-coming head by the classical technic.

Delivery—Spontaneous—There are three phases to the delivery, they coincide with the three mechanisms. The delivery of the buttocks, hips and legs. The anterior hip and leg are delivered first. If the leg is flexed at the knee the foot may be grasped and with only very moderate traction the leg is extended. The leg is then used for traction the thumbs being held anterior and parallel. The posterior leg if flexed may be delivered in the same way. Slight traction is made on the buttocks the thumbs being held as stated above. Dur-

ing these tractions the patient's cooperation is very desirable, she may help even while under analgesia

If the legs are extended, as in a frank breech on the perineum, the forefinger of one hand is inserted between the thigh and abdomen, the thigh is *abducted and flexed*, the foot is grasped and the whole leg extended outside the vulva. In a primipara an episiotomy may be necessary at this stage. A similar maneuver is carried out with the posterior hip and leg and both legs are then delivered. Downward traction is then made, at the same time maintaining anterior rotation of the back. Slow, even traction is made to deliver the trunk until the lower angle of the scapula appears at the vulva. This indicates that the shoulders have passed the inlet of the pelvis and are ready to be delivered.

There are at least three ways to deliver the shoulder girdle. If the anterior shoulder has impinged under the symphysis and its corresponding arm is easily reached, it can be followed from the shoulder to the cubital fossa, the operator using the hand that will apply to that arm, the baby's forearm and hand are reached for and swept across the face or chest of the baby and delivered over the perineum. This done, the operator holds the baby's legs toward the corresponding maternal thigh or higher and reaches for the posterior arm of the baby without necessarily rotating the body. The posterior arm can then be delivered by the same method used for the anterior arm. This maneuver is facilitated by the greater available space in the posterior part of the pelvis. These maneuvers applied to shoulders and arms are called "manual aid."

If the posterior scapula presents first at the vulva or if there is difficulty in reaching the anterior arm the posterior arm and shoulder should be delivered first, i. e., the above maneuvers may be reversed. After the posterior arm is delivered the anterior arm and shoulder can then be reached and delivered with greater ease.

Another method is to deliver both arms and both shoulders as anterior ones. Sometimes during extractions, the arms are removed from their more normal chest attitude, and may be behind the head. The occiput and back are rotated in an opposite direction to free an anterior arm. This is then identified, flexed and brought across the baby's face and chest.

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tion will be required to deliver the after-coming head manually the forceps may be employed. It should be remembered that delivery of the head by the Mauriceau Smellie Veit or Wigand Martin method makes traction on the body neck and head and may subject the cervical plexus medulla tentorium and falx to undue strain and trauma. The forceps has the advantage of making traction on the head alone. For this purpose the long Simpson or the Piper forceps may be used. The latter instrument was especially devised for an after coming head the blades are at a lower level than the shanks and handles. When outward traction is made the head will be delivered downward in the axis of the birth canal and the traction requires very little force. When the forceps operation is done it is a little more difficult than on a forecoming head the body of the child being in the way. The following rules are useful: occiput anterior forceps under baby; occiput posterior forceps over baby.

In about 5 per cent of breech cases the occiput may be posterior and the chin against the symphysis. An attempt might be made to rotate the back anteriorly in the hope that the head will follow. Failing in this the head must be delivered by the so called Prague maneuver forcing the head into the pelvis flexing the trunk and delivering the chin around the symphysis. If the chin can be released from the symphysis forceps may then be applied.

Breech Extraction—This is a major operation in obstetrics and fraught with great danger to mother and baby. Sometimes the breech is arrested at the pelvic inlet particularly in cases of frank breech in contracted pelvis or with a large baby. When the breech is delayed at the pelvic inlet it is spoken of as an arrested breech when it is delayed in the pelvic cavity or on the perineum it is spoken of as an impacted breech. The labor either comes to a standstill or in spite of good pains there is no progress. Treatment. A careful vaginal examination may be necessary to investigate the reasons for the delay. As much information as possible should be gathered during this examination. If delivery per vaginam is possible in the case of an arrested breech (the cervix completely dilated) the breech may be decomposed or broken up. This has reference to straightening out the breech by bring-

The child is then rotated to the opposite side through an arc of 180 degrees to make the posterior shoulder anterior and this is delivered as previously described. This maneuver may sometimes produce damage to the brachial plexus of the baby or tear the maternal soft parts.

Delivery of the arms and shoulders should be slow and deliberate. Babies have been lost at this stage because of very large shoulders. It is necessary, also, to keep the back anterior, as this will favor anterior rotation of the occiput later.

Delivery of the After coming Head by the Mauriceau Smellie Veit or Wigand Martin Maneuver—The former method requires an assistant, the latter can be carried out entirely by the operator. The underlying principle in these methods is to bring the head into the inlet of the pelvis and then to disengage and deliver it in flexion.

After the shoulders have been delivered the widest transverse diameter of the head is at or above the inlet. Under anesthesia the head should be made to enter the pelvis in an oblique diameter in the case of normal and generally contracted pelvis, and in the transverse diameter with lateral displacement and asynclitism in the case of flat pelvis. After the biparietal diameter has passed the inlet, the back and occiput should be rotated anteriorly and the latter now impinged under the symphysis. The trunk rests on the operator's forearm.

assistant makes pressure on the head through the abdominal wall and the head is delivered in flexion (Mauriceau Smellie Veit method). During this maneuver the cord may be drawn down to prevent undue traction upon it. An episiotomy is done or the perineum may be put on a stretch by the insertion of a vaginal retractor to allow the baby to breathe. Be slow and deliberate in all movements. And the mechanism of labor and do not employ undue traction. The old "eight minute rule" about the cord is no longer followed. Allow ten or fifteen minutes if necessary, to deliver the shoulders and after coming head.

Forceps to the After coming Head—If too great trac-

Cesarean Section—This operation is not indicated for breech presentation *per se*. The same strict rules for cesarean section always apply. However if in the presence of even minor degrees of pelvic contraction or disproportion together with the difficulties attendant upon delivery from below with such other factors as primiparity, advanced age, placenta praevia, ablatio placentae and perhaps toxemia the indications may be broadened. This of course obviates the breech mechanisms and maneuvers for delivery from below. Sometimes cesarean section is the wiser choice.

Twins—Twin pregnancy and labor may complicate the delivery. Fortunately in twin pregnancy the babies are smaller and hence disproportion is not a factor. If both babies present by the breech spontaneous breech delivery with manual aid should be encouraged for the first baby. Rupture of the membranes of the second baby can be done and a spontaneous delivery completed. If this fails a carefully conducted breech extraction may be carried out. This is not difficult with a small baby.

If the first of twins is cephalic and the second a breech the second baby may be delivered as described above under breech extraction. If the first is a breech and the second cephalic there may be locked heads. This does not occur commonly. The second baby may be pushed up allowing the first to deliver. If this fails the head of the first may be perforated or craniotomized. Fortunately this is rarely required.

Anesthesia and Analgesia—During the first stage if prolonged a sedative may be used. As previously stated morphine sulfate $\frac{1}{2}$ to $\frac{1}{4}$ grain depending upon the size of the patient and duration of pregnancy smaller doses should be used for premature babies. During the second stage ether or gas oxygen (ethylene, nitrous oxide or cyclopropane) may be used for analgesia. During the expulsive stage these can be increased to deep surgical anesthesia. Various forms of local anesthesia have been employed. Spinal anesthesia should not be used. Parasacral and local infiltration have been employed with some success. Parasacral anesthesia is time consuming and requires exact anatomic and technical skill. Local infiltration is satisfactory and easily carried out. It is safe for spontaneous breech deliveries. Parasacral anesthesia has also

ing one or both legs down. The same may be done with the impacted breech. The hand is inserted into the vagina preferably that hand which will apply to the abdomen of the baby although some operators prefer to use the left hand always. If the anterior leg is within reach it should be brought down if this is impossible then the posterior leg is straightened and brought down the objection to this being that the anterior hip will be impacted behind the symphysis and the body of the child must be rotated through an arc of 180 degrees thus making the posterior hip and leg now anterior. Then the posterior hip and leg are sought for the leg straightened out by bending the knee if necessary and abducting the thigh.

It is not quite so simple in the case of a frank breech. If it is high the uterine cavity must be invaded if low in the pelvis the operation is also difficult because of lack of space. In the case of an arrested frank breech the anterior leg is delivered by a Pinard maneuver. This consists of the insertion of that hand which will apply to the baby's abdomen reaching for the posterior aspect of the knee (popliteal space) tapping it to produce flexion thus bringing the foot into the operator's hand then extending the whole leg and making downward traction until the anterior hip appears under the symphysis. Continued traction must be made on the trunk until the anterior scapula appears and then delivering the shoulders and after-coming head as described above.

High breech extraction cannot be done until the cervix is completely dilated. If the cervix is not completely dilated and it is necessary to deliver the cervix must be incised. An episiotomy is also necessary in a primipara.

If the anterior leg cannot be released the Pinard maneuver may be done on the posterior leg later rotating the baby and thus making the original anterior hip posterior and then freeing it as described above. Breech extraction may easily give rise to intracranial hemorrhage tears of the tentorium and fatal damage to the cervical or brachial plexus.

If in some rare instance the after coming head cannot be delivered and the baby is dead or dying craniotomy may have to be resorted to. This may be necessary also in a hydrocephalic after-coming head. Sometime only perforation may be required.

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been employed for breech extractions as it gives good uterine relaxation. Personally I prefer the general anesthetics because their administration can be easily regulated. The local anesthetics however although they require a special technic do have a place.

Complications — Maternal — In addition to those which already exist as primary factors there may be prolonged labor with its attendant fatigue and danger of infection. The operative incidence is increased. There is more likelihood of soft part injury and its resultant morbidity.

Fetal — Intracranial injury viz hemorrhage laceration of falx or tentorium, injury to clavicles, arms, epiphyses of long bones, ribs, cervical plexus, brachial plexus, medulla and pons with its centers injured and visceral injury such as hemorrhage into adrenals and liver.

Summary — Breech presentation occurs in 3.3 per cent of all presentations. The management of such an error in presentation should begin at about the thirtieth week of pregnancy by attempting prophylactic external version. The maneuver may be repeated once or twice if it fails the first time. There is little danger when it is correctly done. It may avoid the difficulties of breech delivery during labor. When the patient enters labor with a breech presentation external version should not be attempted. Conservatism is the best form of treatment treating the patient as the exigencies of the case demand. Preserve the membranes if possible do not rupture them early. Keep the patient in bed to prevent prolapse of the cord or a foot. Do not resort to early breech extraction bearing in mind that this is a difficult procedure. The operative incidence is of necessity increased. Maternal morbidity, fetal mortality and accidents to the fetus are likewise increased. In the best managed clinics fetal mortality has been reduced from 10 per cent to an almost irreducible minimum of 2.7 per cent. As an after thought it should be mentioned that careful aseptic technic must always be carried out and that breech presentations during labor in both primiparae and multiparae should be conducted in the hospital.

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